بسم الله الرحمن الرحيم

Sudan University of Science and Technology
College of Engineering
School of Mechanical Engineering

Performance Measurement Of Maintenance Management In Industry

IN (G.D. Pasgianos Co.Ltd)

A project submitted in partial fulfillment for the requirements of the degree of B.SC (HONOR) in Mechanical Engineering

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بسم الله الرحمن الرحيم

الآية:

قال تعالى:

"رب إشرح لي صدري ويسر لي امري واحلل عقدة من لساني يفقهوا قولي"

سورة طه – الآية 27

صدق الله العظيم

Dedication

“Successful people are not gifted; they just work hard, and then succeed on purpose”

For every achievement a lot of hard work must be applied to get on the path of success, and guiding from elders that are very dear & important to our hearts.

We dedicate our efforts to our beloved parents & families, without their prays, love, support, guidance, encouragement and compassion, we wouldn’t be where we are today, thank you for everything, you will be always the number one in our hearts.

Acknowledgement

All of this work was going to be impossible without the guidance and the support of our families and teachers.

In particular, we have to give a special thanks to our supervisor, our teacher and the living sample of kindness & urbanity, dr. Wedaa’ allah Elamin for give us always the full knowledge, keys and tools to elevate with us to a better grade.

Also a special thanks for everyone in Pasgianos factory for their cooperation and their full effort to put us on the right track.

And we have to thank every single teacher in our mechanical engineering school (SUST) that had any contribution in our educational ladder advancements.

Abstract

With the increasing of the public (customers) awareness and insistence on products quality, the need for better productions is increasing day by day. Knowing the performance of the maintenance system and its contribution on improving our productivity and trying to improve it; is essential for getting better products at better production rates.

Here in our project, our main focus was to implement the Overall equipment effectiveness "OEE" method in G.D Pasgianos .co Ltd in order to evaluate their maintenance management performance and making suggestions that it will have an actual contribution on increasing the "OEE". This will indicate a significant improvement on the production rate outcomes through the improvement of the maintenance management system.

We measured the "OEE" for May, June and July; the "OEE" was 28.99%, 21.114% & 20.49% respectively.

From our analysis the major problem that had the lowest ratios was the performance (47.250% - 34.474% - 33.276%). So we suggest some corrective actions to increase the performance in particular and the other "OEE" factors slightly, those suggestions are:

1- Provide a complete experts supervision for the machines frequently (every 2 hours for example).

2-Reduction in the unused duty times by reducing the schedule time to fit the needs of each month demands without negative effects in the production rates.

3-Purchasing the latest generation (3rd) for the machines from Krones.

المستخلص

مع الزيادة في الوعي لدى العامة (العملاء والزبائن) وإصرارهم على جودة المنتجات، الحوجة إلى منتجات أفضل تتزايد يوما بعد يوم .

معرفة أداء نظام الصيانة ومساهمته في تحسين الانتاجية ومحاولة تحسينه يعتبر عنصرا أساسيا للحصول على منتجات أفضل بمعدلات إنتاجية أفضل.

هنا في هذا المشروع، هدفنا الاساسي سيكون تطبيق منهجية فعالية المعدات الكلية في مصنع بزيانوس لتقييم أداء نظام الصيانة ، ووضع إقتراحات نعتقد بأنها ستكون لها مساهمة فعلية في زيادة فعالية المعدات الكلية التي ستتسبب في تحسين معدل فعالية المعدات الكلية، وذلك سيكون مؤشرا لتحسن كبير في مخرجات معدل الإنتاجية عبر تحسين نظام إدارة الصيانة لدى المصنع.

حسبت فعالية المعدات الكلية في شهور مايو ويونيو ويوليو ب 28.99% , 21.114% , 20.49% على التوالي.

من التحليل الذي تم إجراءه وجد ان المشكلة الرئيسية ذات المعدلات الأقل هي الأداء (47.250% و 34.474% , 33.276%). لذا تم اقتراح بعض الأفعال التصحيحية في سعينا نحو زيادة عامل الأداء على وجه الخصوص لفعالية المعدات الكلية, وزيادة طفيفة في بقية العوامل. هذه المقترحات هي:

1.توفير خبراء مختصين للإشراف الكلي دوريا على الماكينات(كل ساعتين على وجه المثال).

2.تقليل أوقات العمل غير المنتجة عبر تقليل الوقت المجدول لتناسب احتياجات كل شهر بدون تاثير سلبي على معدلات الإنتاج.

3. شراء الجيل الأحدث (الجيل الثالث) للماكينات المصنعة من قبل شركات كرونز الألمانية.

List of contents

List of figures

List of tables

CHAPTER ONE

INTRODUCTION

Chapter One

Introduction

1.1 Introduction:

Since the beginning of time, humans have always felt the need for the maintenance of their equipment, even the most rudimentary tools. Most of the failures experienced have been a result of abuse, as it sometimes still happens. First, they would do maintenance only when it was no longer possible to run it. That was called "Breakdown or Reactive Maintenance".

In the period of pre-World War II, people thought of maintenance as an added cost to the plant which did not increase the value of finished product.

Therefore, the maintenance at that era was restricted to fixing the unit when it breaks because it was the cheapest alternative.

During and after World War II at the time when the advances of engineering and scientific technology developed, people developed other types of maintenance, which were much cheaper such as preventive maintenance.

In addition, people in this era classified maintenance as a function of the production system. The times and needs changed, in 1960 new concepts were established, "Productive Maintenance" was the name for the new trend which determined a more professional approach. The assignment of a higher responsibility to all the people related to maintenance consisted of a series of considerations about the reliability and design of the equipment and the plant itself. The change was so profound that the term "Maintenance" was changed to "Plant Engineering" and the tasks to be performed, included a higher understanding of the reliability of each element of the machines and installations in general.

1.2 Problem statement:

Low performance of maintenance management affects the quality of the products “downgrade, scrap and rejected” and increases the production time “downtime, breakdowns and emergency shutdowns” and cost of the production process “facility and equipment utilization”.

1.3 Project objectives:

- To examine the maintenance management in G.D. Pasgianos Co. ltd.
- To evaluate the maintenance management in the G.D. Pasgianos Co. ltd. using Overall Equipment Effectiveness “OEE”.
- To suggest corrective actions that will increase the performance of the maintenance management using OEE.

1.4 Project scope:

Evaluate and increase the performance of the maintenance management using OEE “Overall Equipment Effectiveness" In G.D Pasgianos Co Ltd.

CHAPTER TWO

LITERATURE REVIEW

Chapter Two

Literature Review

2.1 Definition of maintenance:

Maintenance is a set of organised activities that are carried out in order to keep an item in its best operational condition with minimum cost acquired.

2.2 Maintenance Objectives:

- Maximising production or increasing facilities availability at the lowest cost and at the highest quality and safety standards.
- Reducing breakdowns and emergency shutdowns.
- Optimising resources utilisation.
- Reducing downtime.
- Improving spares stock control.
- Improving equipment efficiency and reducing scrap rate.
- Minimising energy usage.
- Optimising the useful life of equipment.
- Providing reliable cost and budgetary control.
- Identifying and implementing cost reductions.

2.3 Types of Maintenance:

In the maintenance literature it is generally recognized that maintenance philosophies can be grouped into three broad categories.

Table 2.1: Types of maintenance

		Description	Example
1	Corrective Maintenance (CM)	Maintenance tasks are intentionally withheld until an asset stops working or starts failing. Maintenance is then performed as necessitated.	Lubricate motors when they become noisy or vibrations occur.
2	Preventative Maintenance (PM)	Maintenance tasks are performed at regular intervals, based on industry expected equipment life spans and failure patterns.	Lubricate pumps every 2,000 hours.
3	Predictive Maintenance (PDM)	Maintenance is conduced only when it is confirmed necessary through the use of non-destructive tests that detect potential failure conditions before their occurrence.	Conduct scans on pumps and panels to determine if and when work is required.

2.4 Key performance indicators (KPI):

A performance indicator or key performance indicator (KPI) is a type of performance measurement. KPIs evaluate the success of an organization or of a particular activity in which it engages. Often success is simply the repeated, periodic achievement of some levels of operational goal (e.g. zero defects, 10/10 customer satisfaction, etc.), and sometimes success is defined in terms of making progress toward strategic goals. Accordingly, choosing the right KPIs relies upon a good understanding of what is important to the organization. 'What is important' often depends on the department measuring the performance - e.g. the KPIs useful to finance will really differ from the KPIs assigned to sales. Since there is a need to understand well what is important, various techniques to assess the present state of the business, and its key activities, are associated with the selection of performance indicators. These assessments often lead to the identification of potential improvements, so performance indicators are routinely associated with 'performance improvement' initiatives. A very common way to choose KPIs is to apply a management framework such as the balanced scorecard.

2.4.1 Categorization of indicators:

Key performance indicators define a set of values against which to measure. These raw sets of values, which are fed to systems in charge of summarizing the information, are called indicators. Indicators identifiable and marked as possible candidates for KPIs can be summarized into the following sub-categories:

- Quantitative indicators that can be presented with a number.
- Qualitative indicators that can't be presented as a number.
- Leading indicators that can predict the outcome of a process.
- Lagging indicators that present the success or failure post hoc.
- Input indicators that measure the amount of resources consumed during the generation of the outcome.
- Process indicators that represent the efficiency or the productivity of the process.
- Output indicators that reflect the outcome or results of the process activities.
- Practical indicators that interface with existing company processes.
- Directional indicators specifying whether or not an organization is getting better.

- Actionable indicators are sufficiently in an organization's control to effect change.
- Financial indicators used in performance measurement and when looking at an operating index.

Key performance indicators, in practical terms and for strategic development, are objectives to be targeted that will add the most value to the business. These are also referred to as key success indicators.

2.4.2 KPI examples:

2.4.2.1 Marketing and sales:

Some examples are:

1. New customer acquisition.
2. Demographic analysis of individuals (potential customers) applying to become customers, and the levels of approval, rejections, and pending numbers.
3. Status of existing customers.
4. Customer attrition.
5. Turnover (i.e., revenue) generated by segments of the customer population.
6. Outstanding balances held by segments of customers and terms of payment.
7. Collection of bad debts within customer relationships.
8. Profitability of customers by demographic segments and segmentation of customers by profitability.

Many of these customer KPIs are developed and managed with customer relationship management software.

Faster availability of data is a competitive issue for most organizations. For example, businesses which have higher operational/credit risk (involving for example credit cards or wealth management) may want weekly or even daily availability of KPI analysis, facilitated by appropriate IT systems and tools.

2.4.2.2 Supply chain management:

Businesses can utilize KPIs to establish and monitor progress toward a variety of goals, including lean manufacturing objectives, minority business enterprise and diversity spending, environmental "green" initiatives, cost avoidance programs and low-cost country sourcing targets.

Any business, regardless of size, can better manage supplier performance with the help of KPIs robust capabilities, which include:

- Automated entry and approval functions.
- On-demand, real-time scorecard measures.
- Rework on procured inventory.
- Single data repository to eliminate inefficiencies and maintain consistency.
- Advanced workflow approval process to ensure consistent procedures.
- Flexible data-input modes and real-time graphical performance displays.
- Customized cost savings documentation.
- Simplified setup procedures to eliminate dependence upon IT resources.

Main SCM KPIs will detail the following processes:

- Sales forecasts.
- Inventory.
- Procurement and suppliers.
- Warehousing.
- Transportation.
- Reverse logistics.

Suppliers can implement KPIs to gain an advantage over the competition. Suppliers have instant access to a user-friendly portal for submitting standardized cost savings templates. Suppliers and their customers exchange vital supply chain performance data while gaining visibility to the exact status of cost improvement projects and cost savings documentation.

2.4.2.3 Manufacturing:

Overall equipment effectiveness, is a set of broadly accepted non-financial metrics which reflect manufacturing success.

2.5 Overall equipment effectiveness:

Overall Equipment Effectiveness (OEE) measures total performance by relating the availability of a process to its productivity and output quality. OEE addresses all losses caused by the equipment, including:

- Not being available when needed because of breakdowns or set-up and adjustment losses
- Not running at the optimum rate because of reduced speed or idling and minor stoppage losses.
- Not producing first-pass A1 quality output because of defects and rework or start-up losses.

OEE was first used by Seiichi Nakajima, the founder of total productive maintenance (TPM), in describing a fundamental measure for tracking production performance. He challenged the complacent view of effectiveness by focusing not simply on keeping equipment running smoothly, but on creating a sense of joint responsibility between operators and maintenance workers to extend and optimize overall equipment performance. First applied in discrete manufacturing, OEE is now used throughout process, batch, and discrete production plants.

So through a bottom-up approach based on the Six Big Losses model, OEE breaks the performance of equipment into three separate and measurable components: Availability, Performance and Quality.

$$OEE = Availability \times Performance \times Quality$$

• Availability: it is the percentage of time that equipment is available to run during the total possible Loading Time. Availability is different than Utilization. Availability only includes the time the machine was scheduled, planned, or assigned to run. Utilization regards all hours of the calendar time. Utilization is more effective in capacity planning and analyzing fixed cost absorption. Availability looks at the equipment itself and focuses more on variable cost absorption. Availability can be even calculated as:

$$Availability = \frac{Loading\ Time - Downtime}{Loading\ Time}$$

• Performance: it is a measure of how well the machine runs within the Operating Time. Performance can be even calculated as:

$$Performance = \frac{Actual\ operating\ output\ rate}{Ideal\ operating\ output\ rate}$$

• Quality: it is a measure of the number of parts that meet specification compared to how many were produced. Quality can be even calculated as:

$$Quality = \frac{Actual\ output\ (units) - Defect\ amount\ (units)}{Actual\ output\ (units)}$$

After the various factors are taken into account, all the results are expressed as percentage that can be viewed as a snapshot of the current equipment effectiveness.

The value of the OEE is an indication of the size of the technical losses (machine malfunctioning and process) as a whole. The gap between the value of the OEE and 100% indicates the share of technical losses compared to the Loading Time.

Putting OEE to work:

The OEE calculation provides focus and simplicity to aid in decision making. It can help you.

• Identify areas for improvement.

• Assess incremental revenue opportunities.

• Benchmark your operation against similar or competitor processes.

For example, by tracking the factors that determine OEE, you can determine whether your equipment experienced more downtime (planned or unplanned) than expected, or was running at a slower pace or with minor stops, or produced more defects. Root cause analysis begins by focusing on the type and extent of loss, not the OEE percentage rating itself. Both Operations and Maintenance should be involved in making improvements — whether reducing unplanned downtime, increasing process productivity, or improving product quality.

Table 2.2: OEE world - class by Nakajima

World – class overall equipment effectiveness	Percentages
Availability	>90%
Productivity	>95%
Quality	>99%
OEE	>85%

This table is taken from (PlantWed University _OEE 101_2002).

Here are some case studies that use OEE method to evaluate the performance of different industries in different countries.

2.6 CASE STUDIES:

2.6.1 Case study:

This study is done in the Automobile parts manufacturing sector using Injection Molding at M/s.**Unitech Plasto Components Pvt. Ltd.,** Mugalivakkam, and Chennai.

The company was facing some problems due to break downs, equipment defects and poor working condition. The management of company took a decision to overcome these problems by implementing TPM concept. The management also took a decision if there is an improvement in the overall equipment efficiency, and then this method will be extended to other machines.

OEE = 61.34%

2.6.2 Case study:

XYZ is one of the prestigious automobile manufacturing organizations in India. With the dual objective of industrial and agriculture growth, XYZ was established in 1970. XYZ, is India's first large-scale project based company with a totally indigenous design, know-how and technology. XYZ is a leading manufacturing organization manufacturing tractors, harvesting combines, fork lifters etc. Till 1998, the organization did not give much attention to the maintenance work. The machines were being checked and repaired only after the breakdown. But with the industrialization, it became necessary to adopt new concepts to survive in the market. The organization decided to adopt “Total Productive Maintenance

(TPM)” for its survival.

According to Nakajima (Nakajima 1988), OEE measurement is an effective way of analyzing the efficiency of a single machine. It is a function of availability, performance rate, and quality rate. OEE is calculated for all the machines before and after implementation.

OEE for Broaching Machine –I.

Before TPM Implementation

OEE = Availability x Efficiency x Quality

= 80% x 76.9% x 95.5% = **58.7%**

After TPM Implementation

OEE = Availability x Efficiency x Quality

= 85.1% x 83.1% x 99% = **70%**

After successful implementation of TPM, it is found that Overall Equipment Effectiveness is increased

2.3.3 Case study:

Jamna auto industries Limited is ISO-9001 certified company, the study has been carried out on parabolic and eye rolling machine. These machines have selected because there efficiency and performance were very low and also unsafe because of 100% air cleaning.

Data collected for the past four months. The operation is based on the three shifts per day every shift is for eight hours the planned down time per shift 15min at the end of each shift for cleaning and tiding up the work area. To understand the current levels of performance, it was planned to calculate the OEE.

1. Eye rolling machine

Before TPM:

On November and December respectively

OEE = 85.45 and 84.26

After TPM:

On January and February respectively

OEE = 92.52 and 95.47

2. Pokler machine:

Before TPM:

On November and December respectively

OEE = 89.66 and 84.12

After TPM:

On January and February respectively

OEE = 94.18 and 94.85

From the analysis of overall equipment effectiveness and the proper implementation of TPM the company has finally achieves reduce downtime of machine, increase output/month, availability, performance efficiency and quality performance which result increase OEE of machine.

CHAPTER THREE

METHODOLOGY

Chapter Three
Methodology

3.1 Introduction:

Our method is to implement the OEE concept to measure the performance of the maintenance system in G.D Pasgianos factory, and then increase it as much as possible.

3.2 OEE principles & factors:

The Effectiveness of the equipment is the Actual Output over the Reference Output. Equipment Effectiveness shows how effectively an equipment is utilized. Overall Equipment Effectiveness shows the effectiveness of a machine compared to the ideal machine as a percentage. OEE is essentially the ratio of Fully Productive Time to Planned Production Time. In practice, however, OEE is calculated as the product of Availability, Performance and Quality.

$$\text{OEE} = \text{Availability X Performance Rate X Quality Rate}$$

3.2.1 Availability:

Is the ratio of Operating Time to Planned Production time? It represents the percentage of schedule time that the equipment is available to operate.

$$\text{Availability} = \frac{\text{Available Time} - \text{Unplanned Downtime}}{\text{Available Time}}$$

$$\text{Available Time} = \text{Total Available Time} - \text{Planned Downtime}$$

- Planned Downtime:

Excess Capacity, Planned breaks, planned maintenance, Communication break or Team meetings.

- Unplanned Downtime:

Breakdowns, Setup and Adjustment, Late material delivers, Operator availability.

3.2.2Performance Rate:

Performance is the ratio of Net Operating Time to Operating Time. It represents the speed at which the equipment runs as a percentage of its designed (Ideal) speed. It takes into account Speed Losses.

$$\text{Performance} = \frac{\textit{Actual operating output rate}}{\text{Ideal operating output rate}}$$

3.2.3Quality Rate:

Quality is the ratio of Fully Productive Time to Net Operating Time. It represents the Good units produced as a percentage of the Total units produced.

$$\text{Quality Rate} = \frac{(\text{Total Produced Parts} - \text{Defects Parts})}{\text{Total Produced parts}}$$

3.3Philosophy:

First we went to Pasgianos factory to see the production flow there, and then we took the last 3 months data to implement the OEE principles on them to measure the performance of their production operation for each month individually.

After getting the results of OEE for each month, we analyzed the data to determine the machines with the highest amount of downtime to be attacked first, then we got the maintenance reports from the maintenance department on the factory to see the defects and problems that led to those downtime levels for each machine that had been categorized as a critical machine in the last analysis, and finally we studied those problems and defects to get an appropriate economically efficient solution for each problem.

CHAPTER FOUR

RESULTS & DISCUSSION

Chapter Four

Results & Discussion

4.1 Production line components:

The factory contains two production lines, only one of them is functional currently.

Note that the whole line works as a unit, so if any part of this line experience any kind of defects that will affect the functionality of that part, the whole line will stop.

The production line is comprised from the following major four parts:

4.1.1 Blow mold:

Here the preform (hollow plastic parts) is formed to the desired shape.

Figure 4.1: Blow mold machine

4.1.2 Filler:

It is the machine that fills the beverages into the bottles on a large scale.

Figure 4.2: Filler machine

4.1.3 Labeller:

This machine applies the labels to the beverages bottles.

Figure 4.3: Labeller machine

4.1.4 Variopac:

This machine is responsible of enclosing or protecting products for distribution, storage, sale and use.

Figure 4.4: Variopac machine

4.2Factory facts:

- The factory operates in two shifts through a 24 hours period, the first shift starts from 8a.m to 8p.m, and then the second one operates between 8p.m and 8.am.
- At Fridays, the factory stop its production process due to maintenance activities performed during the whole day.
- The management board addresses the orders requested from the customers to the sections managers (production manager, maintenance manager and so on), then the production manager directs his operators to start the production.
- The process is then monitored manually by monitoring operators with no background about the production line machines to report any problems that occur in each machine, the problem will be controlled by the maintenance department to get the production flow back on track.
- The filling machine speed for 2L bottles is 7000b/h, and for the 0.5&0.6L bottles is 14000b/h.

4.3 Results:

The data is gathered through three months which had been the months under study, their data and the calculations are listed below:

4.3.1 May 2016:

4.3.1.1 Data:

Table 4.1: monthly report

PET LINE										
Flavor	Total Packets Produced	Total Bottle Produce	Actual Hrs	Theoretical HRS	Var. Hrs	Efficiency	Utilization	contribution	planned downtime machine	Filled bottle waste %
Pasgianos (0.5)	69,211.0	1,661,064.0	167.5	118.6	-48.9	70.8%	0.0	24%	0.0	0.62%
Orange (0.5)	26,563.0	637,512.0	59.9	45.5	-14.4	76.0%	0.0	9%	0.0	0.81%
Pasg Light (0.5)	3,827.0	91,848.0	9.4	6.6	-2.8	69.8%	0.0	1%	0.0	0.99%
pear (0.5)	4,846.0	116,304.0	17.2	8.3	-8.9	48.3%	0.0	2%	0.0	1.86%
pineapple (0.5)	4,867.0	116,808.0	12.9	8.3	-4.6	64.7%	0.0	2%	0.0	1.09%
Lemon (0.5)	2,751.0	66,024.0	7.5	4.7	-2.8	62.9%	0.0	1%	0.0	1.05%
forat Water(0.6)	157,793.0	1,893,516.0	191.0	135.3	-55.7	70.8%	0.0	55%	0.0	0.00%
forat Water(1.5)	0.0	0.0	0.0	0.0	0.0	0.0%	0.0	0%	0.0	0.00%
pasgianos (2L)	10,508.0	63,048.0	15.6	9.0	-6.6	57.7%	0.0	4%	0.0	0.00%
Orange (2L)	4,370.0	26,220.0	8.1	3.7	-4.4	46.2%	0.0	2%	0.0	0.91%
Total	284,736	4,672,344	489.10	340.12	-148.98	69.5%	90.3%	100%	30.87	7.32%

Table 4.2: Downtimes per minute

Break Down time Mode	Pasgianos (0.5)	Orange (0.5)	Pasg Light (0.5)	pear (0.5)	pineapple (0.5)	Lemon (0.5)	forat Water(0.6)	forat Water(1.5)	pasgianos (2L)	Orange (2L)	Total DT	% Of Total Time
Syrup Room	56	20	0	0	0	0	0	0	7	0	83	0.3%
Video Jet	45	12	0	0	58	0	0	0	10	3	128	0.4%
Cooling unit	3	0	0	0	0	0	27	0	0	70	100	0.3%
Water Treatment	0	0	0	0	0	0	0	0	0	0	0	0.0%
LP Air Comp.	19	0	0	118	65	0	10	0	0	0	212	0.7%
Cap Feed	1	5	0	0	0	0	0	0	0	0	6	0.0%
Pac Conveyor	0	8	0	0	0	0	18	0	16	0	42	0.1%
Variopac	598	64	0	161	5	9	594	0	115	21	1567	5.3%
CO2 system	0	0	0	0	0	0	0	0	0	0	0	0.0%
Filler	190	123	17	26	22	9	321	0	24	9	741	2.5%
Labeller	568	62	6	114	14	9	570	0	21	63	1427	4.9%
Mixer	49	25	1	7	3	12	32	0	0	5	134	0.5%
Blow Mould	681	370	28	49	80	11	615	0	150	67	2051	7.0%
HP Compressor	0	0	0	0	0	0	28	0	0	0	28	0.1%
Checkmat	0	0	0	0	0	0	0	0	0	0	0	0.0%
Power station	188	46	15	22	0	15	252	0	30	9	577	2.0%
Closer	297	71	80	0	0	0	62	0	0	0	510	1.7%
Bottle Conv	90	28	17	7	8	0	204	0	22	8	384	1.3%
Ozoniser	0	0	0	0	0	0	498	0	0	0	498	1.7%
∑ of Machines DT	2785	834	164	504	255	65	3231	0	395	255	8488	28.9%
Mixer Preparation	185	40	50	20	20	20	200	0	0	20	555	1.4%
CIP	170	185	85	0	80	100	385	0	0	115	1120	2.9%
Change Over	85	0	0	0	0	0	32	0	60	0	177	0.5%
∑ of Planned DT	440	225	135	20	100	120	617	0	60	135	1852	4.8%
No Production	2186	320	0	80	0	0	3213	0	450	0	6249	16.3%
Others	490	90	30	0	0	0	230	0	0	0	840	2.2%
∑ of Un unplanned DT	2676	410	30	80	0	0	3443	0	450	0	7089	18.5%
Total DT	5901	1469	329	604	355	185	7291	0	905	390	17429	52.3%

Table 4.3: Waste rates

Waste					
	Run 1	Run2	Run3	Total waste	% Of Total Prod.
Green Preform 25.5	27575	10039	0	28,051	**1.52%**
Green Preform 50G	2061	0	0	2,061	**3.17%**
Clear Preform25.5G	6725	1887	2763	11,375	**1.75%**
Clear Preform50G	1167	0	0	1,167	**1.82%**
Brown Preform	5711	0	0	5,711	**2.39%**
Brown Blue 17.67G	21782	3252	1967	27,001	**1.41%**
Brown Blue 39 G	0	0	0	0	**0.00%**
Red Cap	10477	2642	0	13,119	**0.65%**
Blue Cap	4470	878	1428	6,776	**1.01%**
White Cap	373	548	0	921	**0.99%**
water Cap	4977	733	558	6,268	**0.33%**
Shrink Film 40mm	668	59	46	773	**0.49%**
Shrink Film 45mm	92	0	0	92	**0.61%**
Shrink Film 55mm	654	180	7	841	**0.77%**
Pasg Label0.5	13073	2551	0	15,624	**0.93%**
Pasg Label2L	916	0	0	916	**1.43%**
Orange Label0.5	2998	1403	1197	5,598	**0.87%**
Orange Label2L	157	0	0	157	**0.60%**
Pasg Light Label	237	615	0	852	**0.92%**
Pear Label	1924	0	0	1,924	**1.63%**
Pineapple Label	1559	0	0	1,559	**1.32%**
Lemon Label	0	659	0	659	**0.99%**
water 0.6 label	10435	1406	295	12,136	**0.64%**
water 1.5 label	0	0	0	0	**0.00%**
Filled B Pasg0.5	8336	1944	0	10,280	**0.62%**
Filled B Pasg2L	0	0	0	0	**0.00%**
Filled B Orange0.5	2879	878	1428	5,185	**0.81%**
Filled B Orange2L	240	0	0	240	**0.91%**
Filled B Pear	2209	0	0	2,209	**1.86%**
Filled B Pineapple	1283	0	0	1,283	**1.09%**
Filled B Pasg Ligh	373	548	0	921	**0.99%**
Filled B Lemon	0	698	0	698	**1.05%**

4.3.1.2 Calculations:

Available time = 744 – 30.86667

= 713.1333

$$\text{Availability} = \frac{Available\ time - unplanned\ downtime}{Available\ time}$$

Availability = $\frac{713.1333 - 141.46667 - 118.15}{713.13333}$

Availability = 63.595%

Performance = $\frac{Actual\ output}{Ideal\ output}$

Actual output =4672344

For 2L bottles:

Bottles produced = 89268

Its proportion from the total amount of production = 0.019105

Total hours for 2L bottles related to available time = 13.62441

Ideal for 2L bottles =13.62441(hours) × 7000(bottles/hour)

= 95371 bottles

For 0.5&0.6L bottles:

Bottles produced = 4583076

Its proportion from the total amount of production = 0.98089

Total hours for 0.5&0.6L bottles related to available time = 699.5084

Ideal for 0.5&o.6L bottles = 699.5084(hours) × 14000(bottles/hour)

= 9793119 bottles

Total ideal = 0.5&0.6L ideal + 2L ideal = 9888489 bottles

Performance = 4672344 / 9888489

= 47.2503%

Quality = $\frac{Total\ produced - Rejcted}{Total\ produced}$ = 96.481%

OEE = 28.991%

4.3.2June 2016:

4.3.2.1 Data:

Table 4.4: Monthly report

PET LINE										
Flavor	Total Packets Produced	Total Bottle Produce	Actual Hrs	Theoretical HRS	Var. Hrs	Efficiency	Utilization	contribution	planned downtime machine	Filled bottle waste %
Pasgianos (0.5)	78,594.0	1,886,256.0	216.8	134.7	-82.1	62.1%	0.0	44%	0.0	0.45%
Orange (0.5)	16,103.0	386,472.0	36.9	27.6	-9.3	74.8%	0.0	9%	0.0	0.29%
Pasg Light (0.5)	7,796.0	187,104.0	23.0	13.4	-9.6	58.1%	0.0	4%	0.0	0.64%
pear (0.5)	3,294.0	79,056.0	8.6	5.6	-3.0	65.7%	0.0	2%	0.0	1.75%
pineapple (0.5)	0.0	0.0	0.0	0.0	0.0	0.0%	0.0	0%	0.0	0.00%
Lemon (0.5)	0.0	0.0	0.0	0.0	0.0	0.0%	0.0	0%	0.0	0.00%
forat Water(0.6)	47,980.0	575,760.0	74.0	41.1	-32.9	55.6%	0.0	27%	0.0	0.00%
forat Water(1.5)	0.0	0.0	0.0	0.0	0.0	0.0%	0.0	0%	0.0	0.00%
pasgianos (2L)	9,590.0	57,540.0	20.8	8.2	-12.6	39.5%	0.0	5%	0.0	2.60%
Orange (2L)	14,768.0	88,608.0	22.4	12.7	-9.7	56.5%	0.0	8%	0.0	0.96%
Total	178,125	3,260,796	402.50	243.35	-159.15	60.5%	78.2%	100%	28.92	6.70%

Table 4.5: Downtimes per minute

Break Down time Mode	Pasgianos (0.5)	Orange (0.5)	Pasg Light (0.5)	pear (0.5)	pineapple (0.5)	Lemon (0.5)	forat Water(0.6)	forat Water(1.5)	pasgianos (2L)	Orange (2L)	Total DT	% Of Total Time
Syrup Room	54	22	0	7	0	0	0	0	13	14	110	0.5%
Video Jet	146	15	0	0	0	0	20	0	0	0	181	0.7%
Cooling unit	0	0	0	0	0	0	0	0	34	104	138	0.6%
Water Treatment	42	0	0	0	0	0	0	0	0	0	42	0.2%
LP Air Comp.	0	0	0	0	0	0	0	0	0	0	0	0.0%
Cap Feed	0	0	2	0	0	0	0	0	0	0	2	0.0%
Pac Conveyor	0	0	0	0	0	0	0	0	0	30	30	0.1%
Variopac	1011	51	45	0	0	0	903	0	85	113	2208	9.1%
CO2 system	0	0	0	0	0	0	0	0	0	0	0	0.0%
Filler	347	101	31	94	0	0	162	0	119	66	920	3.8%
Labeller	1262	95	165	10	0	0	290	0	97	81	2000	8.3%
Mixer	65	6	135	12	0	0	12	0	0	7	237	1.0%
Blow Mould	1230	122	149	20	0	0	169	0	248	142	2080	8.6%
HP Compressor	12	0	0	0	0	0	0	0	0	0	12	0.0%
Checkmat	0	0	0	0	0	0	0	0	0	0	0	0.0%
Power station	237	35	10	15	0	0	173	0	28	23	521	2.2%
Closer	161	40	7	0	0	0	23	0	0	3	234	1.0%
Bottle Conv	234	42	16	8	0	0	21	0	102	28	451	1.9%
Ozoniser	0	0	0	0	0	0	176	0	0	0	176	0.7%
∑ of Machines DT	4801	529	560	166	0	0	1949	0	726	611	9342	38.7%
Mixer Preparation	125	40	80	40	0	0	125	0	0	20	430	1.4%
CIP	270	180	260	110	0	0	205	0	0	115	1140	3.6%
Change Over	45	0	0	0	0	0	0	0	60	60	165	0.5%
∑ of Planned DT	440	220	340	150	0	0	330	0	60	195	1735	5.5%
No Production	1520	120	770	585	0	0	250	0	1095	0	4340	13.8%
Others	957	0	0	30	0	0	171	0	0	120	1278	4.1%
∑ of Un unplanned DT	2477	120	770	615	0	0	421	0	1095	120	5618	17.8%
Total DT	7718	869	1670	931	0	0	2700	0	1881	926	16695	62.0%

Table 4.6: Waste rates

Waste					
	Run 1	Run2	Run3	Total waste	% Of Total Prod.
Green Preform 25.5G	36759	7951	463	45,173	2.13%
Green Preform 50G	5416	0	0	5,416	8.60%
Clear Preform25.5G	5587	1899	0	7,486	1.90%
Clear Preform50G	3591	386	0	3,977	6.46%
Brown Preform	3091	0	0	3,091	3.76%
Brown Blue 17.67G	6988	1452	0	8,440	1.44%
Brown Blue 39 G	0	0	0	0	0.00%
Red Cap	11255	189	99	11,543	0.57%
Blue Cap	1456	547	0	2,003	0.42%
White Cap	0	1614	0	1,614	0.86%
water Cap	1829	577	0	2,406	0.42%
Shrink Film 40mm	361	51	0	412	0.85%
Shrink Film 45mm	83	7	0	90	0.37%
Shrink Film 55mm	911	124	3	1,038	1.05%
Pasg Label0.5	15497	365	121	15,983	0.84%
Pasg Label2L	2099	0	0	2,099	3.52%
Orange Label0.5	2263	515	0	2,778	0.71%
Orange Label2L	434	174	0	608	0.68%
Pasg Light Label	0	2409	0	2,409	1.27%
Pear Label	1014	0	0	1,014	1.27%
Pineapple Label	0	0	0	0	0.00%
Lemon Label	0	0	0	0	0.00%
water 0.6 label	3284	887	0	4,171	0.72%
water 1.5 label	0	0	0	0	0.00%
Filled B Pasg0.5	8312	189	99	8,600	0.45%
Filled B Pasg2L	1533	0	0	1,533	2.60%
Filled B Orange0.5	626	516	0	1,142	0.29%
Filled B Orange2L	830	31	0	861	0.96%
Filled B Pear	1410	0	0	1,410	1.75%
Filled B Pineapple	0	0	0	0	0.00%
Filled B Pasg Ligh	0	1214	0	1,214	0.64%
Filled B Lemon	0	0	0	0	0.00%

4.3.2.2 Calculations:

Available time = 720 – 28.91667

= 691.08333

Availability = $\frac{Available\ time - unplanned\ downtime}{Available\ time}$

Availability = $\frac{691.08333 - 155.7 - 93.63333}{691.08333}$

Availability = 63.921%

Performance = $\frac{Actual\ output}{Ideal\ output}$

Actual output = 3260796

For 2L bottles:

Bottles produced = 146148

Its proportion from the total amount of production = 0.04482

Total hours for 2L bottles related to available time = 31.0172

Ideal for 2L bottles =31.0172 (hours) × 7000(bottles/hour)

= 217121 bottles

For 0.5&0.6L bottles:

Bottles produced = 3114648

Its proportion from the total amount of production = 0.95518

Total hours for 0.5&0.6L bottles related to available time = 660.10897

Ideal for 0.5&o.6L bottles = 660.10897(hours) × 14000(bottles/hour)

= 9241526 bottles

Total ideal = 0.5&0.6L ideal + 2L ideal = 9458647 bottles

Performance = 3260796 / 9458647

= 34.474%

Quality = $\frac{Total\ produced - Rejcted}{Total\ produced}$ = 95.814%

OEE = 21.114%

4.3.3 July 2016:

4.3.3.1 Data:

Table 4.7: Monthly report

PET LINE										
Flavor	Total Packets Produced	Total Bottle Produce	Actual Hrs	Theoretical HRS	Var. Hrs	Efficiency	Utilization	contribution	planned downtime machine	Filled bottle waste %
Pasgianos (0.5)	73,496.0	1,763,904.0	199.4	126.0	-73.4	63.2%	0.0	45%	0.0	0.43%
Orange (0.5)	13,088.0	314,112.0	29.3	22.4	-6.9	76.6%	0.0	8%	0.0	0.22%
Pasg Light (0.5)	5,242.0	125,808.0	16.3	9.0	-7.3	55.1%	0.0	3%	0.0	0.83%
pear (0.5)	11,161.0	267,864.0	39.7	19.1	-20.6	48.2%	0.0	7%	0.0	1.49%
pineapple (0.5)	12,653.0	303,672.0	32.0	21.7	-10.3	67.8%	0.0	8%	0.0	0.64%
Lemon (0.5)	2,709.0	65,016.0	7.9	4.6	-3.3	58.8%	0.0	2%	0.0	1.27%
forat Water(0.6)	28,513.0	342,156.0	32.5	24.4	-8.1	75.2%	0.0	17%	0.0	0.00%
forat Water(1.5)	0.0	0.0	0.0	0.0	0.0	0.0%	0.0	0%	0.0	0.00%
pasgianos (2L)	17,995.0	107,970.0	35.1	15.4	-19.7	43.9%	0.0	11%	0.0	2.28%
Orange (2L)	0.0	0.0	0.0	0.0	0.0	0.0%	0.0	0%	0.0	0.00%
Total	164,857	3,290,502	392.20	242.75	-149.45	61.9%	67.0%	100%	25.83	7.16%

Table 4.8: Downtimes per minute

Break Down time Mode	Pasgianos (0.5)	Orange (0.5)	Pasg Light (0.5)	pear (0.5)	pineapple (0.5)	Lemon (0.5)	forat Water(0.6)	forat Water(1.5)	pasgianos (2L)	Orange (2L)	Total DT	% Of Total Time
Syrup Room	60	16	0	18	2	0	0	0	20	0	116	0.5%
Video Jet	30	0	0	0	0	0	0	0	0	0	30	0.1%
Cooling unit	569	0	0	139	136	0	0	0	0	0	844	3.6%
Water Treatment	0	0	0	0	0	0	0	0	0	0	0	0.0%
LP Air Comp.	0	0	0	0	0	0	0	0	0	0	0	0.0%
Cap Feed	14	0	0	0	0	0	0	0	0	0	14	0.1%
Pac Conveyor	14	0	0	0	0	0	0	0	7	0	21	0.1%
Variopac	1458	78	96	60	133	0	14	0	209	0	2048	8.7%
CO2 system	0	0	0	0	0	0	0	0	0	0	0	0.0%
Filler	460	40	29	31	48	47	38	0	219	0	912	3.9%
Labeller	616	54	186	346	149	69	244	0	211	0	1875	8.0%
Mixer	44	0	0	0	5	40	5	0	0	0	94	0.4%
Blow Mould	463	69	53	391	68	24	49	0	311	0	1428	6.1%
HP Compressor	119	10	0	9	0	0	14	0	0	0	152	0.6%
Checkmat	0	0	0	0	0	0	0	0	0	0	0	0.0%
Power station	217	0	20	67	0	0	11	0	64	0	379	1.6%
Closer	42	85	3	13	8	0	4	0	0	0	155	0.7%
Bottle Conv	78	21	5	51	9	3	29	0	63	0	259	1.1%
Ozoniser	0	0	0	0	0	0	46	0	0	0	46	0.2%
∑ of Machines DT	4184	373	392	1125	558	183	454	0	1104	0	8373	35.6%
Mixer Preparation	305	20	20	125	140	110	85	0	100	0	905	2.8%
CIP	95	85	85	155	125	60	40	0	0	0	645	2.0%
Change Over	0	0	0	0	0	0	0	0	0	0	0	0.0%
∑ of Planned DT	400	105	105	280	265	170	125	0	100	0	1550	4.8%
No Production	4449	0	545	0	0	20	70	0	1057	0	6141	19.2%
Others	420	0	0	190	40	0	60	0	85	0	795	2.5%
∑ of Un unplanned DT	4869	0	545	190	40	20	130	0	1142	0	6936	21.7%
Total DT	9453	478	1042	1595	863	373	709	0	2346	0	16859	62.1%

Table 4.9: Waste rates

Waste					
	Run 1	Run2	Run3	Total waste	% Of Total Prod.
Green Preform 25.5G	24,382	7,847	0	32,229	1.62%
Green Preform 50G	10,860	0	0	10,860	9.14%
Clear Preform25.5G	5,438	0	705	6,143	1.92%
Clear Preform50G	0	0	0	0	0.00%
Brown Preform	4,873	13,060	0	17,933	3.04%
Brown Blue 17.67G	2,509	0	0	2,509	0.73%
Brown Blue 39 G	0	0	0	0	0.00%
Red Cap	11,191	6,059	0	17,250	0.69%
Blue Cap	623	0	56	679	0.22%
White Cap	166	885	0	1,051	0.83%
water Cap	334	0	0	334	0.10%
Shrink Film 40mm	220	0	0	220	0.77%
Shrink Film 45mm	123	0	0	123	0.68%
Shrink Film 55mm	560	288	10	858	0.75%
Pasg Label0.5	14,273	3,382	0	17,655	0.99%
Pasg Label2L	3,379	0	0	3,379	3.03%
Orange Label0.5	1,808	0	174	1,982	0.63%
Orange Label2L	0	0	0	0	0.00%
Pasg Light Label	54	2,013	0	2,067	1.62%
Pear Label	1,045	5,667	0	6,712	2.44%
Pineapple Label	1,760	1,600	0	3,360	1.09%
Lemon Label	816	384	0	1,200	1.81%
water 0.6 label	2,513	0	0	2,513	0.73%
water 1.5 label	0	0	0	0	0.00%
Filled B Pasg0.5	6,460	1,135	0	7,595	0.43%
Filled B Pasg2L	2,520	0	0	2,520	2.28%
Filled B Orange0.5	623	0	56	679	0.22%
Filled B Orange2L	0	0	0	0	0.00%
Filled B Pear	611	3,448	0	4,059	1.49%
Filled B Pineapple	1,295	667	0	1,962	0.64%
Filled B Pasg Ligh	166	885	0	1,051	0.83%
Filled B Lemon	330	509	0	839	1.27%

4.3.3.2 Calculations:

Available time = 744 – 25.83333

= 718.16667

$$\text{Availability} = \frac{Available\ time - \text{unplanned}\ downtime}{Available\ time}$$

Availability = $\frac{718.16667 - 139.55 - 115.6}{718.16667}$

Availability = 64.472%

Performance = $\frac{Actual\ output}{Ideal\ output}$

Actual output = 3290502 bottles

For 2L bottles:

Bottles produced = 107970

Its proportion from the total amount of production = 0.0328

Total hours for 2L bottles related to available time = 23.5558

Ideal for 2L bottles =23.5558 (hours) × 7000(bottles/hour)

= 164891 bottles

For 0.5&0.6L bottles:

Bottles produced = 3182532

Its proportion from the total amount of production = 0.9671

Total hours for 0.5&0.6L bottles related to available time = 694.5389

Ideal for 0.5&o.6L bottles = 694.5389(hours) × 14000(bottles/hour)

= 9723545 bottles

Total ideal = 0.5&0.6L ideal + 2L ideal = 9888436 bottles

Performance = 3290502 / 9888436

= 33.276%

Quality = $\frac{Total\ produced - Rejcted}{Total\ produced}$= 95.509%

OEE = 20.49%

4.4 Discussion:

The results of OEE for each month shown above are classified as a low percentage as we mentioned in the previous chapters that the world class OEE is in the range of 85%.

Those percentages got law like this off course because of some reasons, so we made an analysis for each month data to determine the major problems that have the biggest contribution on these poor percentages.

The following charts indicate the largest downtimes in each machine for the three months:

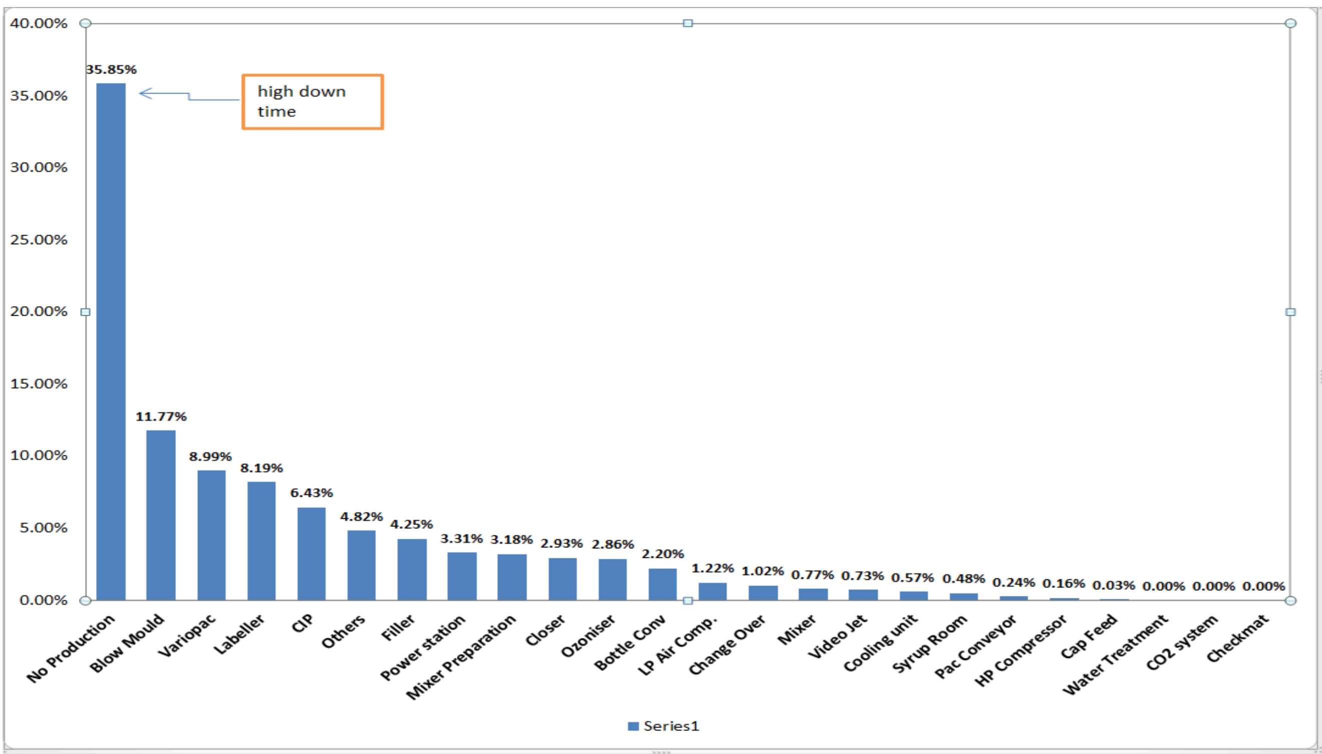

Figure 4.5: downtimes at May

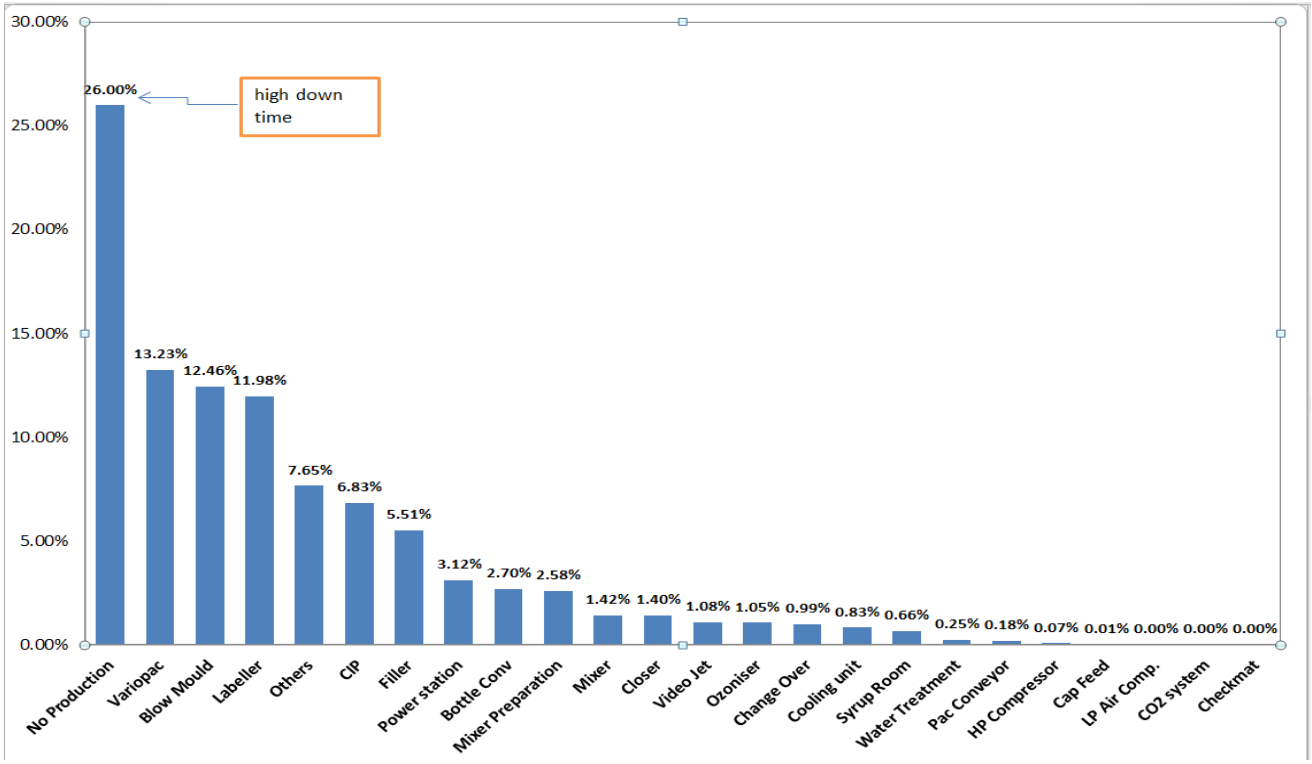

Figure 4.6: downtimes at Jun

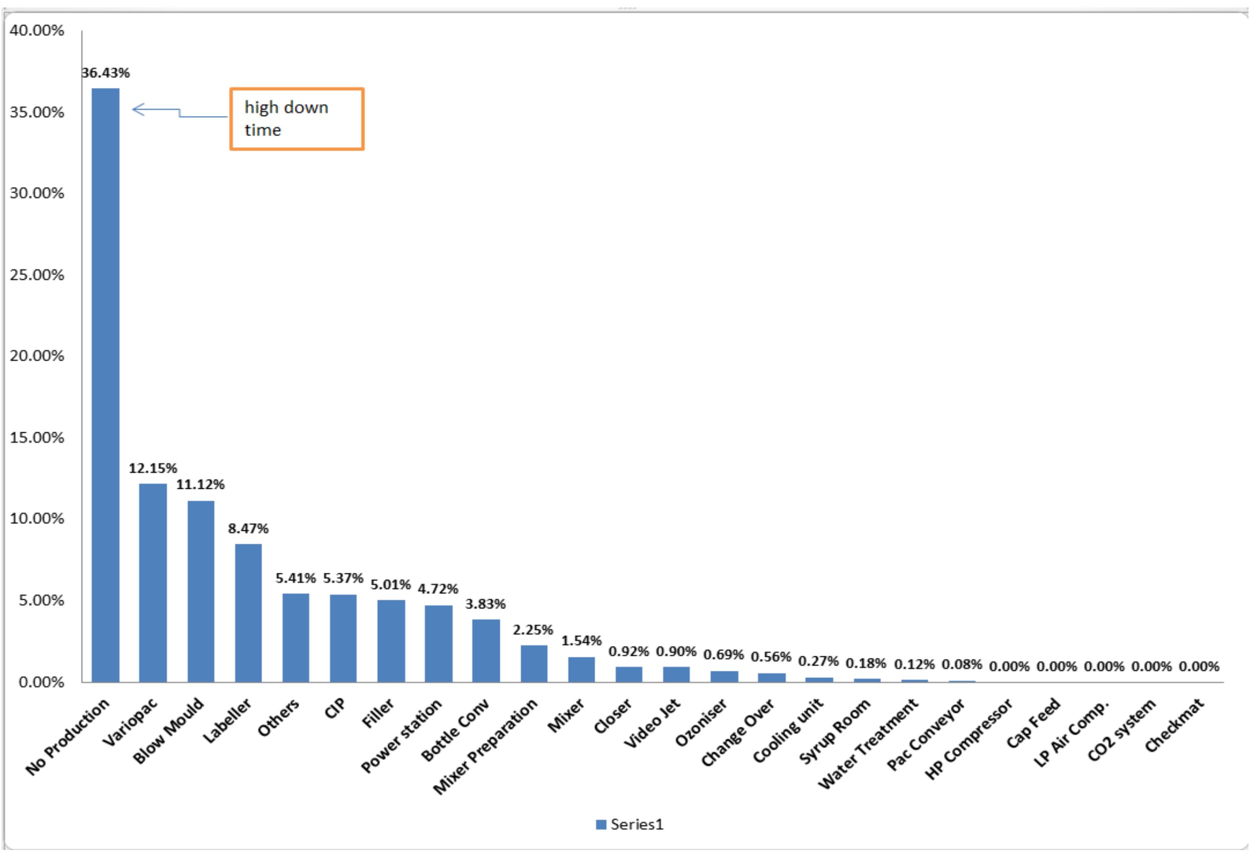

Figure 4.7: downtimes at July

Generally, the biggest downtime values were on:

- No production
- Variopac
- Blow mold
- Labeller

From the analysis made by generating these charts, we can determine the major problems that had the biggest effect on the lack of efficiency of "OEE" to be triggered & attacked first.

The Pasgianos factory works by the order concept (getting orders at the beginning of each month and then getting more orders during the month or cancel others), so there is a lot of wasted times due to the large unused times occurred on each month.

For this case we suggest making adjustments to the scheduled time with the demands of each month, so the duty durations will be adjusted based on the demands of each month to reduce the amount of each schedule time in each month, by this way their basis for their working days will be reduced for every single month without having any negative impact in their production rates, but with a high improvement on their availability rate though.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATIONS

Chapter Five
Conclusion and Recommendations

5.1 Conclusion:

In summary, we studied and understood Pasgianos production work flow, their working concepts and basically everything about their procedures during an ordinary full working day, and then we implemented the OEE method that helped us to achieve the following:

1. We measured the "OEE" for May (28.99%), June (21.114%) & July (20.49%).
2. The "OEE" rates are poor compared with its world classification (85%).
3. The weakest "OEE" factor was the performance rate.
4. The largest downtime levels are in the no production state, the Variopac, the Blow molder and the labeller machines.

This approach that had been followed here & implemented through the project is based on our own knowledge, maybe there are other new approaches, and maybe there are even better ones.

5.2 Recommendations:

1. We suggest having a frequent supervision from expert workers for the control panels (every 2 hour for example) to discover & control the defects earlier.
2. We suggest making adjustments to the scheduled time with the demands of each month.
3. We should also suggest that maybe the owners of the Pasgianos .co Ltd should consider purchasing the new 3rd generation of the Krones machines for significant improvements on their overall efficiency.
4. For further investigations and studies at the field, we suggest putting attention in studying the Variopac, blow molder and labeller machines, so that you can increase their efficiencies through reducing their downtimes levels.

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