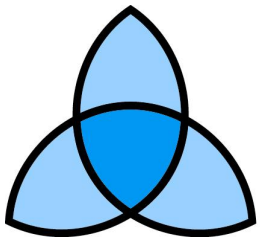

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South East European University

Faculty of Business and Economics

Finance and Accounting

MASTER THESIS

Topic: Operational Efficiency Improvement with Lean Manufacturing Implementation: With Particular Emphasis on The Positive Effects from The Implementation of Kaizen in Lean

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Prepared by:

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Tetovo, December 2020

Declaration

I hereby declare that this Master's thesis is my own original work and personal effort. All sources used when writing the thesis have been cited in the references paragraph.

I have read the South East European University current research ethics guidelines and accept responsibility in accordance with the University's Rule on Student Conduct.

Acknowledgment

I would like to express and extend my sincere thanks to several persons for their time and support and who especially deserve my acknowledgement. Without them this master thesis would not been such a pleasant work.

First and foremost, gratitude I owe is to **God Almighty** for giving me good health, strength and will in order to finish this dissertation.

It is my privilege to thank my lovely parents for their constant encouragement and constant support given throughout my studies. Many thanks for believing in me and teaching me to work hard in order to succeed. I dedicate this thesis to both of you.

I would like to bring my heartfelt thanks to my husband and my son, who have always steered me in the right direction giving me a good feeling and confidence.

Furthermore, I would like to thank Johnson Matthey staff and Lean Department for their information given throughout practical part of this master thesis. It was wonderful experience and a very interesting project which helped me to explore and learn this new knowledge area. I am not sure many master students have had the opportunity by being allowed to work within such a company with 200 years' experience.

Last but not least, I would like to express my deepest gratitude to all my family, loved ones for their continuous support. Also, appreciation to my Mentor, Professor Doctor Gadaf Rexhepi for accepting to supervise my research, for wise advice and kind assistance.

Abstract

The North Macedonian companies currently face with the issue about finding better mechanism or strategy for better results by using less resources as possible in order to be more competitive in the market.

The research aim is to identify the role of Lean Manufacturing with particular Emphasis on the positive effects from the implementation of Kaizen in Lean. This research studies the benefits, effects, and impact of Lean, Kaizen and 5S on employee mindset, that comes as a result of lean implementation in a business organization by dedicated team such as Lean department.

Moreover, the paper aims to describe that Lean Tools and Techniques such as: 5S, Kaizen, Standard Work and Visual Management are linked very close together and related with a very important impact in the overall process of implementation of Lean Manufacturing. With this research we aim not just to understand the positive effects from Lean Implementation, but also to identify the results of literature review with a real case study in a company where the Lean Manufacturing it is implemented, to understand the whole Kaizen process how it is organized etc.

To test the hypothesis that Lean Manufacturing helps reducing time in the work process, helps reducing costs, increase savings and encouraging employees to be creative and develop a mindset for continues improvements and problem solving, data collection was conducted internally within the company through observation and by conducting case study in the factory. The results proved and confirmed the hypothesis.

We conclude that when implementing Lean, a company eliminate waste, reduce costs and increasing savings in man hours, line hours, improving employee's satisfaction. In terms of employees this research proves that Johnson Matthey has instead experience as they are encouraged to participate in continuous improvement every day.

Abstrakt

Kompanitë e Maqedonisë së Veriut aktualisht përballen me çështjen në lidhje me gjetjen e mekanizmit ose strategjisë më të mirë për rezultate më të mira duke përdorur më pak burime të mundshme në mënyrë që të jenë më konkurrues në treg.

Qëllimi i hulumtimit është të identifikojë rolin Lean Manufacturing me theks të veçantë në efektet pozitive nga zbatimi i Kaizen në Lean. Ky hulumtim studion përfitimet, efektet dhe ndikimin e Lean, Kaizen dhe 5S në mindset-in e punonjësve, që vjen si rezultat i zbatimit të Lean në një organizatë biznesi nga një ekip i dedikuar siç është departamenti i Lean.

Për më tepër, punimi synon të përshkruajë se si Lean Mjetet dhe Teknikat si: 5S, Kaizen, Puna Standarde dhe Menaxhmentit Vizual janë të lidhura shumë ngushtë njëra me tjetrën së bashku dhe me një ndikim shumë të rëndësishëm në procesin e përgjithshëm të implementimit të Lean Manufacturing. Me këtë hulumtim ne synojmë jo vetëm të kuptojmë efektet pozitive nga Lean Implementation, por gjithashtu të identifikojmë rezultatet e rishikimit të literaturës me një rast studimi real në një kompani ku Lean Manufacturing është i zbatuar, për të kuptuar të gjithë procesin e Kaizen se si është‌organizuar etj.

Për të testuar hipotezat që Lean Manufacturing ndihmon në zvogëlimin e kohës në procesin e punës, ndihmon në uljen e kostove, rrit kursimet dhe inkurajon punonjësit të jenë kreativ dhe të zhvillojnë një mindset për përmirësim të vazhdueshëm dhe zgjidhjen e problemeve, mbledhja e të dhënave u krye brenda kompanisë, përmes vëzhgimit dhe kryerjen e rastit të studimit në fabrikë. Rezultatet vërtetuan dhe konfirmuan hipotezën.

Ne konkludojmë që kur impelentohet Lean, kompania eliminon humbjet, zvogëlon kostot dhe rrit kursimet në orë e punonjësi, orët e linjës, përmirëson satisfaksionin e punonjësve. Për sa i përket punonjësve, ky hulumtim dëshmon se Johnson Matthey ka përvojë në drejtim të inkurajimit të tyre të marrin pjesë në përmirësimin e vazhdueshëm çdo ditë.

Абстракт

Компаниите на Северна Македонија актуелно се соочуваат со прашањето за изнаоѓање на подобар механизам или стратегија за подобри резултати со користење на што помалку ресурси со цел да бидат поконкурентни во пазарот.

Целта на истражувањето е да ја идентификува улогата на Lean Manufacturing со посебен акцент на позитивните ефекти од имплементирањето на Kaizen во Lean. Ова истражување ги студира придобивките, ефектите и влијанието на Lean, Kaizen и 5S врз начинот на размислување на вработените, што доаѓа како резултат на Lean имплементација во деловна организација од посветен тим како што е одделот за Lean.

Покрај тоа, овој трудот има за цел да опише дека Lean алатките и техниките како што се: 5S, Kaizen, Стандардна работа и Визуелен Менаџмент се поврзани многу блиску еден до друг и со многу важno влијание во целокупниот процес на импелемнтирање на Lean Manufacturing. Со ова истражување имаме за цел не само да ги разбереме позитивните ефекти од имплементацијата на Lean, туку и да ги идентификуваме резултатите од прегледот на литературата со вистинско case study во компанија каде што е имплеменитрано Lean Manufacturing, за да се разбере целиот процес на Kaizen како е организирано и сл.

За да се тестираат хипотезите дека Lean Manufacturing помага во намалување на времето во работниот процес, помага во намалувањето на трошоците, ги зголемува заштедите и ги охрабрува вработените да бидат креативни и развиваат mindset за континуирано подобрувања и решавање на проблеми, собирањето на податоци беше спроведено внатрешно во рамките на компанијата преку обзервација и case study во фабриката. Резултатите ги докажаа и потврдија хипотезите.

Заклучуваме дека при имплементација на Lean, компанијата го елиминира отпадот, ги намалува трошоците и ги зголемува заштедите во човечки работноти часови, линиски работни часови , го подобрува сатисфакцијата на вработените. Во однос на вработените, ова истражување докажува дека Џонсон Мети имал искуство во однос дека тие се охрабруваат да учествуваат во континуирано подобрување секој ден.

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FIRST CHAPTER: STUDY FRAME WORK

1.1 Introduction

Nowadays, companies are very concerned about finding better and better results by using less resources as possible in order to survive and overcome high competition, globalized markets, economic downturns and cost effects that require them to pursue this policy.

Lean Manufacturing strategy, known as the Japanese manufacturing method that was developed mainly in Toyota as the Toyota Production System. Many companies have tried to implement it as a whole system or part of the strategy in order to improve their internal processes. Lean Manufacturing is a way of achieving the challenge of high achievement by eliminating waste or activities that do not add value to the production process. It also increases customer satisfaction, improves organizational performance and results in general.

While Kaizen means continuous improvement, and therefore the philosophy of the kaizen is also the starting point and the leader for all lean production initiatives. Although many companies are able to implement process changes, not all are able to support them due to lack of planning, ineffective execution, or an inability to increase accountability within the organization.

Companies in the Republic of North Macedonia can say that they have little or no knowledge of what Lean Manufacturing really is and what Kaizen is and how powerful this system is, except some International Companies on the Free Industrial Zones. For this reason, this research work will aim to clarify the role and importance of implementation of Lean Manufacturing - 5S and KAIZEN.

1.1 Research Goals and Objective

The objective of this master research is to highlight how Implementation of Lean Manufacturing can improve the operational efficiency or business processes with high quality and acceptable costs.

Moreover, the paper aims to describe that Lean Tools and Techniques such as: 5S, Kaizen, Standard Work and Visual Management are linked together and closely related with a crucial impact in the overall process of implementation of Lean Manufacturing.

Specifically, the research has the following objectives:

- To understand the positive effects from Implementation of Kaizen and 5S;
- To identify the results of literature review with the real investigation and a case study in a company where the Lean Manufacturing it is implemented;
- To understand the whole process of Kaizen implementation how it is organized;
- To understand nearly Lean Tools and techniques applicable in manufacturing.

1.2 Research Question

As it is mentioned above It can be said that companies in North Macedonia have little or no knowledge of what Lean Manufacturing really is and Kaizen also.

For this reason, this research paper will show the role and importance of implementation of Lean Manufacturing and KAIZEN as a strategy that helps and aims at how business processes can be improved by achieving sustainable business performance and customer satisfaction by providing products and services quickly and with quality close to perfection. Therefore, the following research questions have been formulated:

Which benefits could a company gain when implementing Lean Manufacturing?

SECOND CHAPTER: LITERATURE REVIEW

2.1 Lean Overview

The base for the Lean was Toyota Production System (TPS). Ford Mass Production system was not suitable for Toyota because of the smaller market and the requests for different models. That is why the Toyota developed new production system with increasing the production's flexibility and cutting the wastes. This was the Toyota Production System. In late 80' the researchers have made analysis of the international automotive industry. The Toyota's system of accomplishing more with less was named, simply, Lean.

The origin of lean production was Toyota's campaign against waste in the in 1950s due to shortage of both capital and resources, and the need to stop the use of resources on poor process quality (Ohno, 1988).

The term "Lean" firstly was used by Krafcik (1988). Lean concepts mostly are evolved from Japanese industries especially from Toyota. By many authors Lean Manufacturing is

considered to be a technique of waste reduction, but in practice lean manufacturing is maximizing the value of the product through minimization of waste (Sundar at al., 2014).

The most popular definition is given by Lonnie Wilson (2010) for Lean Manufacturing and the Toyota Production System usually is: “It is a set of techniques that, when are combined, will allow you to reduce and after that to eliminate the 7 wastes” (Wilson,2010 p.9).

Lean concept means using less human resources, inventory, space, investment in tools and time spend to develop products (Womack at al.,1990). Lean focuses on delivering high quality products on an acceptable price and proper time, in the same time eliminating waste or non-value added (NVA) activities (Womack and Jones, 1996).

With Lean Implementation:

- Everyone has the power to contribute and influence on the company performance
- Employees are encouraged to participate in waste reduction through continuous improvement

Lean ideology shows that Lean is not limited to one type of industry or size of company, but to all types of them which are determined to increase their competitive advantages, operations and profits in the regional markets and globally (Alkhoraif at al.,2019).

2.2 Lean Principles

In order to understand what is Lean Production firstly we need to understand the Principles where Lean Production it is based on, in that way to understand the whole picture of Lean, having all the elements together as a system.

As per the book *The Toyota Way* (Liker, 2004) most companies are looking lean as a toolbox and not understanding lean as a whole system. A company can take set of Lean tools or methods which thinks are more appropriate for such a problem and implement.

Jeffrey K.Liker (2004) describes 14 principles of the Toyota Way. Principles that can be seen as a guide of how to work with lean, these key principles also drive the techniques and tools of the Toyota Production System. The 14principles in order to be more easy for understanding, Jeffrey K.Liker (2004) had divided into four different categories, where all of them are starting with “P” known as “4P” model of Toyota Way.

Below will be presented the 4P Model and 14 lean principles.

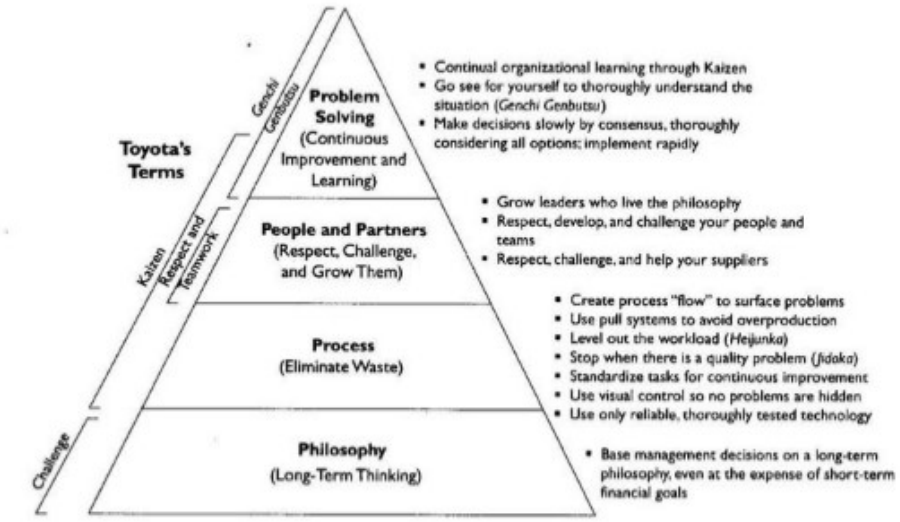


Figure 1 Source. Liker,2009 p.6 A "4P" Model of the Toyota Way.

Anyway, Lean is business philosophy that it is focused on understanding and motivating people to build a "Lean culture", which can help you to become the best on your costs, quality and service in the long -term. (Liker,2009)

2.2.1 "4P" Model

Using the below principles, it is very important because they are like as guidelines for transforming the organization into lean organization.

- **Philosophy**

  The first and the fundamental level of this model is Long -Term Philosophy, the main focus for the high level of the company is to add value to customers and the society. All management decisions should be based on a long-term philosophy. Without believing in this foundation none continue improvement and learning would be possible (Liker, 2004).

- **Process**

  Second level is the Process and this level is where the most' 'lean'' companies are. A lot of companies think that this level represents Lean Concept and are implementing just some Lean tools and methods such as, 5S, pull system, just in time, etc. without understanding lean as an entire system (Liker, 2004).

- **People/Partners**

  The People and Partners level has a deeper focus on teaching the company to "build people" and not just running the business. To create a set of tools that will help

people to improve continually and to develop continually also their employees and partners also by challenging them and assisting too (Liker, 2004).

- **Problem Solving**

  The highest level of the pyramid l focuses on the organizational learning. Identifying the root causes of the problems happened and finding the right countermeasures in order to prevent from happening again the future. Analysis and communication of the best practices is the key of the problem solving (Liker, 2004).

2.2.2 The 14 Principles of the Toyota Way

Principle 1. Base Your Management Decisions on a long-Term Philosophy, Even at the Expense of Short-Term Financial Goal.

In order to be successful with Lean it is very important to understand and ensure that every decision made has a benefit in a long -term. Everyone in the company should work hard to in order to grow and bring the company to the next level. The value that will be generated it will be the value of the whole company, value for the costumers, society and the economy. This principle is the foundation of all other principles (Liker, 2004).

Principle 2. Create Continuous Process Flow to Bring Problems to the Surface

Simplify the work processes in order to achieve value added flow. Create a system of organizational culture where the employees will make the problems visible and will solve the problems themselves in order to eliminate or decrease extra work. And that will help to understand the continues process improvement (Liker, 2004).

Principle* 3*. Use "Pull" System to Avoid Overproduction

A company should focus on minimizing the Work in process and warehousing inventory in order to avoid overproduction. Use the principle Just in Time which means the demand from the customers should control the production. Deliver the right items, in the right amount and at the right time (Liker, 2004).

Principle 4. Level Out the Workload

Making Lean successful it is not just eliminating waste (Muda), but in the same time it is important to eliminate workload (Muri) and unevenness (Mura) in order to making Lean works.

Having a stable workload, a company can also avoid the, often damaging and time consuming, need to turn on and off production (Liker, 2004).

Principle 5. Build a Culture of Stopping to Fix Problems, to Get Quality Right the First Time

This principle shows the importance of fixing the problem immediately when it is detected. Stop and fix now! Not, just keep going with the intention to fix later or just fix the problem temporary and later on fix the same problem will be waste of time and resources. Maybe the productivity will suffer now but in the long run will be enhanced because the root causes are found and countermeasures are put in place as a result of continues improvement process. So, in that way you to get the quality right the first time (Liker, 2004).

Principle 6. Standardized Tasks Are the Foundation for Continuous Improvement

In order to get stabilized processes and the same result or output in the company then standardize. If the employee had followed the standard and a problem again had occurred, then the standard need to be revised and improved. Also involve and use the knowledge and creativity of the employees to improve processes and then incorporate these improvements into new standards, continuously (Liker, 2004).

Principle 7. Use Visual Control So No Problems Are Hidden

This principle indicates to use visible and very simple indicators which will help the employees to see in an easily way if they meet the standard or have a deviation from it. People looking at well-designed charts on a wall can have very effective discussions.5S tool helps a lot in this principle (Liker, 2004).

Principle 8. Use only Reliable, Thoroughly Tested Technology That Serves Your People and Processes

New technology should support people and not to replace them. Always before implementing or using it the new technology need to be tested in order to find out if will support the process or not. Just after testing and proving that it works and can improve the flow of the process then implement quickly. Otherwise the new technology could create big issues to standardize the processes and cannot fit into the process (Liker, 2004).

Principle 9. Grow Leaders Who Thoroughly Understand the Work, Live the Philosophy, and Teach It to Others

This principle emphasize that the real leaders should grow or develop internally and not buying them externally. A good leader must understand and knowing every detail of the daily work, just in that way they can be the best teacher of the employees and in the same time teaching them the company's philosophy (Liker, 2004).

Principle 10. Develop Exceptional People and Teams Who Follow your Company's Philosophy

In order to share the values and beliefs of the company it is necessary to create a stable and a strong culture with training exceptional employees and teams who will work hard continually on the company philosophy in order to achieve exceptional results.

Teamwork it is a key and teaching employees how to work together for a common goal it is something that has to be learned (Liker, 2004).

Principle 11. Respect Your Extended Network of Partners and Suppliers by Challenging Them and Helping Them Improve

This principle concerns the power of supply chain. It is important to understand that suppliers are as an extension of your business you need to grow together for a mutual benefit in long term. Treat them fairly and discipline them, it shows that you value them by setting high targets and challenging them to grow and develop in the same time by assisting them (Liker, 2004).

Principle 12. Go and See for Yourself to Thoroughly Understand the Situation

The twelfth principle concerns about having a deep understanding of the real situation before making decisions. This by going to where it happens, Gemba, observe personally and verify data then solve the problem based on that and not based on what other people are saying or computer screen was showing to you. Even TOP Management level should go and see as much as possible with their own eyes (Liker, 2004).

Principle 13. Make Decisions Slowly by Consensus, Thoroughly Considering All Options; Implement Decisions Rapidly

How you arrive on the decision is just as important as the quality of that decision! So, this principle teaches us to no make a decision before taking into consideration all alternatives

and discussing with all peoples involved. Collect their ideas and discuss about the problems and potential solutions, after that agree all together and implement quickly (Liker, 2004).

Principle 14. Become a Learning Organization, Through Relentless Reflections and Continuous Improvement

After establishing the stable process, you have to use continues improvement tools in order to determine the root cause of inefficiencies and find the most effective countermeasures to apply for removing those inefficiencies. Develop countermeasures to avoid the same mistakes to happen again in future. Standardization and learning go together and are the fundamentals for continuous improvement (Liker, 2004).

2.3 Lean Tools and Techniques

It is very important to understand that Lean is not just a set of tools that can be implemented and expect immediate success or to improve processes. Lean is a philosophy; it is a way of thinking. In order to make it work, it is important to understand the concept and to go like a chain through the whole involved parties such as workers, suppliers and consumers.

There are a different lean tools and techniques that companies can apply or implement in order to become a Lean, but below some far from all will be briefly described in the sections below. Lean has a very big collection of tools and methods.

The tools described below are applied in the case study under discussion exactly in the company Johnson Matthey, Skopje, for better analysis and better understanding and many more others also. The most important tools are:

- Kaizen
- 5S
- Visual Management
- Standardized work

Effective application and implementation of lean tools and techniques are enabling the companies to avoid risk of non-value-added activities and in the same time improving business value. (Kafuku,2019).

2.3.3 Visual Management

Visual Management it is very powerful tool in Lean implementation, It was developed in order to communicate faster and effectively in Manufacturing. Later the service sector started to implement also due to its effectiveness. (Parry and Turner,2006). This tool provides very useful information in terms of communication for the costumers and for the employees in the same time. So, the objective is creation of visual language which everybody can understand in efficient way without losing a lot of energy. Visualization is also a perfect way to show problems so in that way nothing is hidden.

If there is not a possibility to see if an item is in the right place, e.g. because of disorder, it is very hard to decide if a problem exists or not. In order to identify where problem could occur before it becomes a fire-fighting task, visual control is very important and another principle of Lean (Liker, 2004).

One of main focuses of Lean is how to work with visualizing and simplifying processes. Visualisation and simplification as a lean tool always are going hand on hand. By making everything as simple and visual as possible, the risk of employees causing problems due to misunderstanding, is reduced dramatically.

Problems are happening daily on the production floor or in a service company. No matter how you're your processes are, issues will arise and will need a resolution. So, early identification of these problems is key to keep running smoothly your business. Implementing visual management for tracking and monitoring your company's business metrics is essential. So that quick identification and response is possible with visual management. There are a variety of ways to display information about the company operations (Ortiz,2006).

Below is a list of common approaches to visual management:

- Production control boards
- Weekly 5S board
- Daily quality board
- Safety board
- Daily productivity board
- Takt monitors

2.3.4 Standard work

The foundation of the lean-house is standardized work. Standardization it means educating employees to make them work all in the same way, which is main condition at the implementation of Lean (Larsson,2008). Standardization it means documenting the current best practice, and it is the basement for continuous improvement.

The standard work effectively will combine materials, employees and machines to produce a product (Ohno,1988). Standardization means creating standard procedures for every single operation so in that way anyone can understand and use them properly (Press, 2002).

Toyota had implemented standardized work into all processes, engineering as well as shop floor. If the work is not standardized it is very hard to improve it and to make the improvement last. As per Liker,2004 if a defect appears, maybe it is because the standard procedure was not followed as should be. If it is followed and errors are still occurring, then the standardization of that task it is necessarily to be investigated and changed or updated (Liker, 2004).

Normally the standard work procedures are placed in each work station and the worker can understand the process and always keep in mind what they have to do.

Taiichi Ohno says “Standard Operations are the mother of improvement. We a never say that the standard operation we now have are the best and there is no room for further improvement”

Standardised work:

- Is the key foundation for Safety, Quality and Cost improvements;
- Provide confidence that everything will be done the same way every time;
- It generates the same results every time regardless of who is doing the process;
- New employees are trained to the same consistent method;
- Gives ability to the workforce to clarify and improve their process;
- It identifies and encourages the elimination of waste and
- Without a standard it is difficult to measure improvement.

Standard work is the best, most efficient, safest, and most practical way of doing work. It is the process of documenting and standardizing all tasks, so that authorized, standard procedures are used at all times, on all shifts, and by all operators and employees.

The best practises and best methods should be agreed, and then documented in a standard work procedure so to leave nothing to chance or personal preference. Operators or employees will know precisely what to do, when to do it, and how long to do it (Ortiz,2006).

Examples of standard work are:

- ✓ Job specific procedures
- ✓ Work instructions
- ✓ Safety requirements and procedure for operating equipment
- ✓ Operator manuals for machinery etc.

Upon writing a standard procedure or manual take care:

- ✓ Keep everything clear and concise
- ✓ Avoid using too much Technical terms
- ✓ Use recognised and agreed abbreviations
- ✓ Use sketches / photos
- ✓ Do not assume prior knowledge
- ✓ Make it as neat as possible

2.3.1 5S

5S approach it is simple and very universal lean method. It works in lot of companies all over the world. Many researchers and authors have been writing about the definition and the importance of the 5S method.

5S is a concept of housekeeping and it is physical work and very simple for implementation in terms of organising, standardising and maintaining the work environment (Young, 2014; Ortiz, 2006; Yadav at al.,2011).

Roots of 5S are from Japan and it was developed by Hirano (Marria et al.,2014; Jaca et al., 2014). Based on Hirano (1996), 5 pillars are the basement of continues improvement activities.

5S gets its name from five activities beginning with the letter “S”, which were derived from five Japanese words: Seiri; Seiton; Seiso; Seiketsu; Shitsuke, which means to Sort, Set in Order, Shinning, Standardize and Sustain. (Filho et al., 2017; Al-Aomar, 2011; Young, 2014; Omogbai & Salonitis, 2017; Ishijima et al., 2014).

English	Japanese	Definition
Sorting	Seiri	Elimination of unnecessary items from the workplace.
Set in Order	Seiton	Assessment of the work environment / surface and addition of "smart" devices
Shining	Seiso	Remove dirt and debris, inspect equipment and eliminate sources of contamination.
Standardize	Seiketsu	Establish standards to maintain 5S improvements
Sustain	Shitsuke	Monitor, expand & refine 5S results

Table 1 The 5S definitions (Source: Adapted from www.gotopac.com Production Automation Corporation).

When many people learn first for this method, maybe for them it is hard for understanding but Hirano says (1996) that people are practising the 5S in their everyday life without noticing it. E.g. when our home becomes messy and disorganized, massive build-up in factories, etc.

Barriers for 5S Implementation

Any company that starts 5S implementation are facing with types of resistance and barriers. 5S implementation it is not easy because requires drastic changes of the company culture and employee attitude.

Singh at al., (2014) highlights that poor communication is a crucial barrier for 5S Implementation and also, he says that a significant barrier can be also the huge gap between managerial level and shop floor employees also lack of training and 5S awareness.

Attri at al. (2017) mentioned very well the most barriers affecting the 5S implementation as follows:

Barriers
Lack of top management commitment
Financial constraints
Lack of awareness of 5S
Lack of strategic planning for 5S
Lack of employee commitment
Resistance to change and adoption
Lack of cooperation/teamwork
Lack of education and training
Lack of motivation
Inability to change organizational culture
Non-clarity of organization policy about 5S program
Lack of communication
No proper vision and mission
Lack of leadership
Conflict with other quality management system

Table 2 The 5S Barriers (Source: Attri at al.,2017).

As a conclusion, in terms of successfully implementation of 5S it is important everyone to truly understand the 5S, to identify those barriers, to classify and resolve them carefully.

Benefits of 5S Implementation

Many authors (e.g. Agrahari et al., 2015; Al-Aomar, 2011; Voehl et al.,2013, Howell, 2009, Sarkar, 2008; Veres et al,2018) are suggesting that the main focus of this Lean technique is on increasing the productivity and efficiency, eliminating waste, cost saving, reducing time. Similar result Young (2014) concludes that 5S also can be applied to healthcare services and not just in Manufacturing areas and has a lot of benefits in terms of cleaner, organized, efficient workplaces, increased productivity, reduction of inventory costs. (Chourasia & Nema,2016).

According to Chourasia and Nema (2016) and based on their research "Review on Implementation of 5S methodology in the Services Sector" they are concluding that 5S can be implementing in various service industries such as hospitals, hotels, banks and higher education institutions in order to increase their competitiveness.

Based on research done by Maidhili et al. (2014), the paper explains about benefits of 5S implementation and highlights that 5S creates space for better utilization in a workplace. Later on, in 2019 Rizkya at al, on the research paper "5S Implementation in Welding Workshop–a Lean Tool in Waste Minimization" confirms the similar benefit as following: 5S Implementation have ability to reduce the total area used and reducing time for searching.

From the all above I can conclude that 5S approach has many benefits in terms of product quality, increased productivity and efficiency, eliminating waste, lower costs, greater job

satisfaction and many more. On the other side also, we understand that 5S can be implemented not just in manufacturing but also in the service sector.

2.3.2 Kaizen

Kaizen is a Japanese word that means continuous improvement (Ortiz, 2006; Masaaki, 1986; Martin and Osterling,2017; Feld,2000; Press,2002; Rahmanian and Rahmatinejad, 2014; Palmer,2001), kai means “change” and zen “to make good”. Above two words means to take something and change in order to make it better.

Lean production itself was founded based on the idea of kaizen as a continues improvement process. (Press,2002; EPA, 2003). Kaizen it is a building block of all other lean methodologies. Simply, Kaizen means how to produce efficiently using limited resources as manpower, material and machines.

Figure two is illustrating the meaning of Kaizen as a very simple example of saving time and effort.

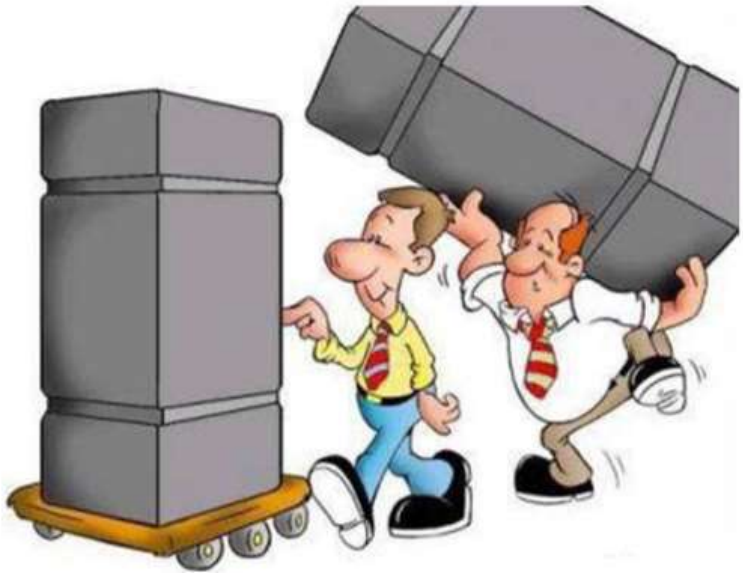


Figure 2 Thinking of Kaizen (Source: Abdulmouti (2018) p.7).

With Kaizen everyone in the organization it is involved in terms of bringing improvements, commit to better quality and improve productivity. (Masaaki, 1986; Ortiz, 2006; EPA, 2003) As per the researchers Maarof and Mahmud, 2016, Kaizen can be used as tool to improve the productivity based on lower costs.

The purpose of Kaizen it is to focus on each process and operation in order to add value and eliminate waste.

Let's have a look what does it mean process, operation, value, add value and waste in order to understand and have a clear picture about Kaizen:

- "A **process** is the sequence of operations needed to design, manufacture and deliver a product or service. It includes the people machines, material and the method used" (Press, 2002, p.5);
- "An **operation** is one activity performed by a single machine or person on that product or service" (Press, 2002, p.5);
- "**Value** is a worth of a product or service delivered to a costumer "(Press, 2002, p.5);
- "**Value added** refers to any operation in a process that changes raw material into value for the costumer" (Press, 2002, p.5) and
- "**Waste** is any operation that adds cost or time but not add value" (Press, 2002, p.5).

There are seven wastes which were initially identified by Taiichi Ohno during the development of the Toyota Production System:

1. **Overproduction**- it means producing more than it is required, faster than needed, and before it is needed. (Ortiz, 2006; Martin and Osterling, 2017) and often it is called a mother of all 7 wastes (Pereira, 2009).
2. **Waiting**-it means people are waiting and doing nothing for example waiting for Information, waiting due to equipment downtime, poor communication etc (Ortiz, 2006; Martin and Osterling,2017; Elnamrouty and Abushaaban, 2013).
3. **Transportation**- it means movement of "things" that does not add any value to the product, such as moving materials between workstations. Because material movement requires manpower, forklifts, paperwork, and all of these is costing (Ortiz, 2006; Martin and Osterling,2017; Pereira, 2009; Elnamrouty and Abushaaban, 2013).
4. **Overprocessing** -it means doing more than a customer asks for (Martin and Osterling,2017; Pereira, 2009).

5. **Inventory**- it means having high levels of raw materials, works-in-process (WIP) and finished goods even it is not necessary (Elnamrouty and Abushaaban, 2013).
6. **Motion**-it means movement of employees that does not add value to the product or service basically due to poor layout, poor visual management, employees are reaching for something, looking for, turning for etc (Martin and Osterling,2017; Pereira, 2009; Ortiz, 2006).
7. **Defects** - is means any work that is below than the level the customer has requested. In addition to physical defects which directly add to the costs of goods sold, this may include errors in paperwork, late delivery etc (Elnamrouty and Abushaaban, 2013; Pereira, 2009). Many Leans practitioners recently had added an eight waste which is (Martin and Osterling, 2017; Liker, 2004; Ortiz, 2006).
8. **Wasted human potential**- it means not utilizing the full capacity of the employees such as skills, knowledge, creativity etc. (Martin and Osterling,2017) Employees should be encouraged to use their creativity to find improvement ideas, solving problems, etc (K. Liker, 2004) with Kaizen Implementation (Ortiz, 2006).

So, identifying above mentioned wastes and elimination of them can be very easy if the companies are using the Kaizen technique. The same conclusion comes from Goyal and al. ,2019 from his research "Waste reduction through Kaizen approach: A case study of a company in India". He also describes according to his case study that hazardous waste was reduced for 13.8% with help of raised Kaizens in the manufacturing process and in the same time was highlighting that there was needed very low investment.

Principles of Kaizen

Based on Masaaki,1986 contribution, Berger (1997) proposes three Kaizen principles which are very important on Kaizen implementation:

1 Process-oriented system-In order to have better output and best quality the processes need to be improved continually (Bates at al.,2012).

2 Continuous improvement and maintenance of standards-Kaizen it is oriented to maintain and improve standard through Continues Improvement in the organization and if there is any variation of the defined standards, corrections and corrective measures should be taken (Masaaki,1986). So, all processes need to be documented before and after

improvement. Improvements should be standardized and documented as procedures and after that all the employees should be trained for the same mentioned procedures.

3 People-based culture-Kaizen gives very special focus on the value of employees. In terms of every employee should be involved in identifying wastes and eliminating them by continues improvement. According to this, every company need to make sure that everyone on the company understands the importance of kaizen across all level of organization and give suggestion for future improvements. Every employee first needs to improve his or her own working methods, attitude etc. Just in this way they can have and raise a continues improvement culture.

2.4 Positive effects from The Implementation of Kaizen

After implementation of Kaizen techniques several benefits are gained which can be reflected on many aspects of the organisation (García at al.,2014). Manos, A. (2007) on his paper "The benefits of Kaizen and Kaizen events" very well is describing these benefits by categorising them into two main categories:

- Quantitative Benefits-Which can be measurable such as:
  - Money saved
  - reduced time
  - reduced inventory
- Qualitative Benefits-Which can be more difficult to measure such as:
  - Employee satisfaction
  - More control over areas
  - Continues improvement culture

From the overall picture and based on my opinion Kaizen implementation results a lot of benefits such as:

- Waste elimination;
- Increasing the productivity;
- Improving quality;
- Improving work safety
- Reducing number of accidents on the work places
- Cost Reduction;

- Raising customer satisfaction;
- Improving employee satisfaction;
- Communication improvement, etc.

2.5 Research papers conclusions and summaries upon the Kaizen benefits

Based on research paper of Abdulmouti (2018) "Benefits of Kaizen to business excellence: Evidence from a case study" results from implementing kaizen principles using relevant kaizen tools are a lot, starting with increasing efficiency for 27% in terms of reducing manpower, increasing the annual output for 13%, savings about 3.3 million US $, etc. In terms of efficiency also Añon et al,2018 was concluding that Kaizen methodology increase efficiency.

According to the Rahmanian and Rahmatinejad,(2014) research "Impact of Kaizen implementation on performance of manufacturing companies' one of the conclusion is the advantage of Kaizen is that is leading to greater quality and more productivity. The results of this study were that when kaizen was firstly implemented, the management figure out an increase of 30%, 50% and even 100% in productivity without any major investments.

Similar results, were also founded by Desta at al. (2014) also concludes that Manufacturing Industries from Northern Ethiopia also benefited from Kaizen implementation. They have reduced production costs, improved their quality, reduced lead time, improved customers' satisfaction. Another author such as Lemma (2016) in his research highlights the role of Kaizen in economic transformation based on increasing productivity within individual firms.

Several authors agreed on the benefit which is related with employees. Kaizen creates more enjoyable atmosphere where employees are feeling more satisfied because their suggestions are valued and implemented. The point is to motivate employees to believe that their ideas can make a difference which it is crucial. Kaizen activities bring out the best in every employee, (Gupta and Jain, 2014) because everyone is encouraged to come up with small improvement ideas regularly. Kaizen gives a chance to every individual of the company to have a hand in achieving organization's goals (Kumar,2018). Kaizen is a system that involves everyone in the organisation starting from top management till to the cleaning team. It is not happening just monthly or yearly, it is continuing. On Japan companies like Toyota and Canon almost 70 improvement ideas per employee are collected, shared and implemented (Maidhili et al.,2014). Abdulmouti (2018) also tells that in TOYOTA Creative Suggestion System produces about 1,000,000 ideas per year with a principle of 'Good Thinking, Good Products'.

Kaizen philosophy is a system that also includes our everyday life and not just a business life, focusing on achieving continuous improvement (Masaki, 2001). It is a concept that can be applied in every aspect, including social activities (Maidhili et al.,2014). Implementing Kaizen in our daily life can improve the quality of life and health (Bingham, 2011; Suárez-Barraza et al., 2013).

THIRD CHAPTER: METHODOLOGY

3.1 Research Methodology and data collection

This master research was carried out on one purposively-selected UK manufacturing company based in Free Industrial Zone in Skopje that has implemented lean manufacturing system. The informants in this master research were the employees and management staff who were also purposively-selected from the departments that relate to Lean implementation, namely from the production and lean department. Data collection was conducted internally within the company through observation and by conducting case studies of the factory. After that the data was compiled and categorized in such a way in order to provide a summarized comprehensible representation of all data.

3.1.1 Who is Johnson Matthey?

Johnson Matthey is a British multinational manufacturing which is specialized in chemicals and sustainable technologies . JM headquarter it is in the United Kingdom, exactly in the city Royston.

Johnson Matthey origins starts since 1817 from a single office in London the it built a global presence in more than 30 countries. (https://en.wikipedia.org/wiki/Johnson_Matthey)

JM support their customers' needs from 43 major manufacturing sites all around the globe, from South Africa to North Macedonia, the USA or China. (https://matthey.com/about-us/where-we-operate). In the 2017 was marked the 200th anniversary of Johnson Matthey.

JM Clean Air sector is in charge for reducing emissions from vehicles and other sources in in very effective and efficient way. Related industries are:

- Automotive
- Energy generation and storage
- PGM and refining (https://matthey.com/about-us/our-sector-structure)

JM are pioneers in the field of emission controls, having made the first commercial emission control catalysts in 1974. As world leaders in the technology, JM have been working for more than forty years to help make the world's air cleaner, creating ever-more sophisticated systems to remove pollutants from a wide range of sources. One in three cars on the road use a JM catalyst and 20 million tons of pollutants were stopped in their tracks each year. (https://matthey.com/markets/automotive)

3.1.2 What is an Auto Catalyst?

A catalyst is a substance that accelerates a chemical reaction but is not being consumed in the reaction itself. Auto Catalysts are ceramic or metallic. The harmful exhaust gases react together on the metallic blocks (substrates) formed into a fine honeycomb structure which is then coated with a catalyst containing mixture (washcoat). The washcoat is made up of a high surface area support and Platinum Group Metals (PGM) that act as catalysts.

3.1.3 How does it work?

An Auto Catalyst is installed into the exhaust system of a car. The harmful gases released during combustion are released down the exhaust and pass through the Auto Catalyst. The harmful exhaust gases react together on the PGM catalyst surface and are converted into more environmentally friendly gases.

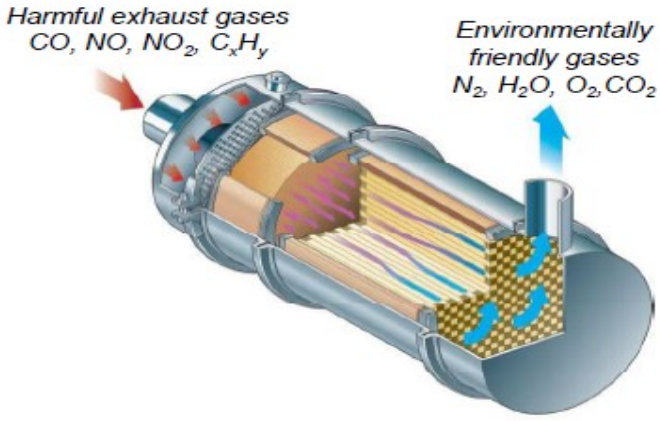


Figure 3 Auto Catalyst.

FOURTH CHAPTER: RESEARCH RESULT AND DATA ANALYSIS

4.1 Research results

In this part is presented the whole case study realised in Johnson Matthey Skopje Plant about 5S Implementation project and Kaizen in PGM Tooling Room.This project is not the first process improvement done in Johnson Matthey.

LEAN Manufacturing was implemented in JM in 2010 and in JM Skopje in the summer of 2011. There is special department called Lean Department who was in charge of supporting implementation of lean standards, facilitating basic overview training about lean for all JM employees. They were conducting and following up lean cultural assessments and reporting site status and activity results also administrate with the Kaizen suggestion system in order to implement improvement ideas from all employees of the company.

So, all employees are informed about LEAN and every new employee that joins JM family in the induction week they have training for LEAN principles and the way of LEAN implementation in JM. So, in everyday work employees are encouraged to work based in LEAN principles!

The intent of the training is to promote a culture of continuous improvement by encouraging employees to be creative in order to make 5S and Kaizen improvements.

4.1.2 Introduction of 5S project

Before starting to work on the 5S project an action plan was prepared in order to not to be defocused and the same was updated in timely fashion as the actions were completed.

Step	Start Date	Target Date	Action	5S	Progress
1	Sep 2017	Sep 2017	5S Assessment	/	Done
2	Sep 2017	Oct 2017	Initial Cleaning and separation	First "S"	Done
3	Sep 2017	Oct 2017	Empty red Area and create right condition to define order system	First "S"	Done
4	Oct 2017	Jan 2018	Define Order system, visual management and prepare condition for temporary cleaning standard	Second "S"	In Progress
5	Jan 2018	Feb 2018	Define temporary Cleaning and control system that maintain right level and order	Third "S"	In Progress
6	Feb 2018	Mar 2018	Team Define and create standard for order, cleaning, Environment and safety	Fourth "S"	Planned
7	TBD	TBD		Fifth "S"	TBD

Table 3 Action Plan for 5S.

So, on the first step the 5S assessment was done, where was necessary to be answered some questions like Why, Where and Why there? which are answered below from the responsible project employees: On the question:

WHY? - 5S was decided to be implemented due to need of ….

- better visual control - Visual Factory
- better quality
- to increase safety
- waste reduction
- better organisation
- better image for the factory
- it creates a positive routine
- increased productivity
- better usage of the available space

Where? - In PGM tooling room. Place where all tools used in production area are sent to be cleaned. Before pictures were taken in order to be shown the starting conditions:

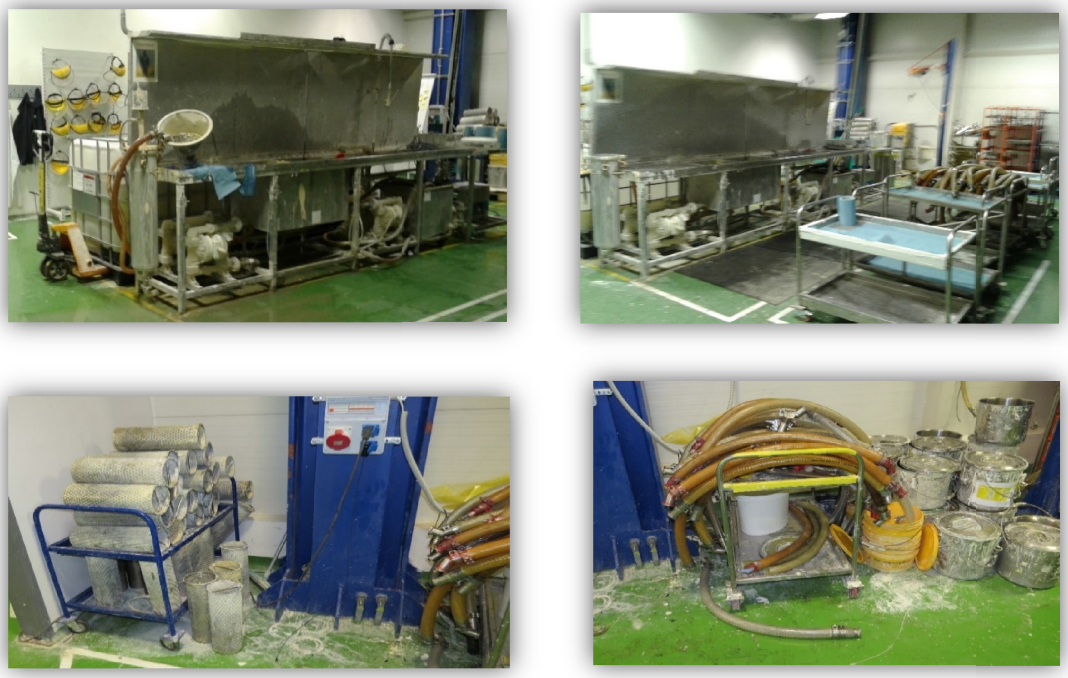


Figure 4 Starting Conditions in PGM Tooling Room.

Why there? - Because of wastes identified in the PGM Tooling Room…

- Low safety level;
- Water drainage from washing table (wet floors);

- Too much time lost in searching of tools;
- Poor level of cleanliness on tools and inventory;
- Too much un-needed items;
- Too much time used to prepare parts for line;
- Poor organisation of space;
- Over-processing (cleaning tools and parts several times due to poor organisation);
- No standard was present;
- No stock level monitoring;
- No visual aids or visually represented standards;
- No dedicated team and
- Damaging of equipment due to poor organisation.

Before starting the project, the below actions were defined such as:

- Definition of the team;
- Ratio for needed people;
- Definition of responsibilities;

The 5S team were responsible for developing the implementation plan, and the selection of team members was based on ability, organizational representation and experience.

The role of team was crucial and with high importance in the application of 5S so that 5S activities occur as planned.

In terms of defining the team they defined some roles team roles such as:

- Operators (one person per group in Production);
- Line Coordinator (who was in charge of coordination of the Operators);
- Line Supervisor (who was in charge of supporting and supervising the Line Coordinator) and
- Production Line Manager (who was in charge of supervising and supporting all subordinates)

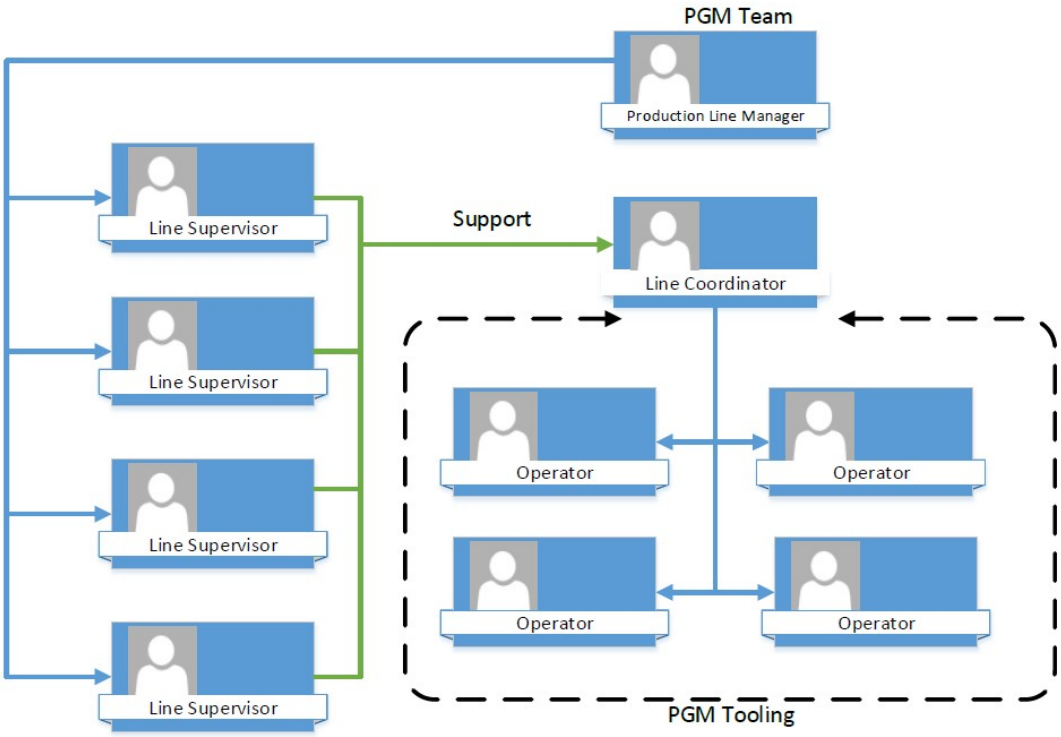


Figure 5 Defined team for PGM Tooling room.

So, one person was dedicated to the PGM Tooling room, one person per shift in order to have coverage 24/7 in all three shifts. So, in total 4 people

4.1.3 Process flow diagrams

After team definition, Lean department organized a training for 5S and also presented the Process flow diagram for 5S steps to the team in the office. The training it was not very successful. Then was decided to go directly on the shop floor and the training to be held in the PGM tooling Room. So, the team was exactly in the place where the 5S implementation was going to be applied and there they have clearer picture what activities were needed to be done.Below prepared process flow diagrams of each 5S step which was necessary to be implemented in the case study are very general.

If the evaluation of the steps it is O, the involved team can continue with implementing the follow step if not, then they have to re-check the points of failing and work again till the implementation of each “S” is ok to continue. But it is understandable some steps can be applicative some of them not, in specific workplace or project.

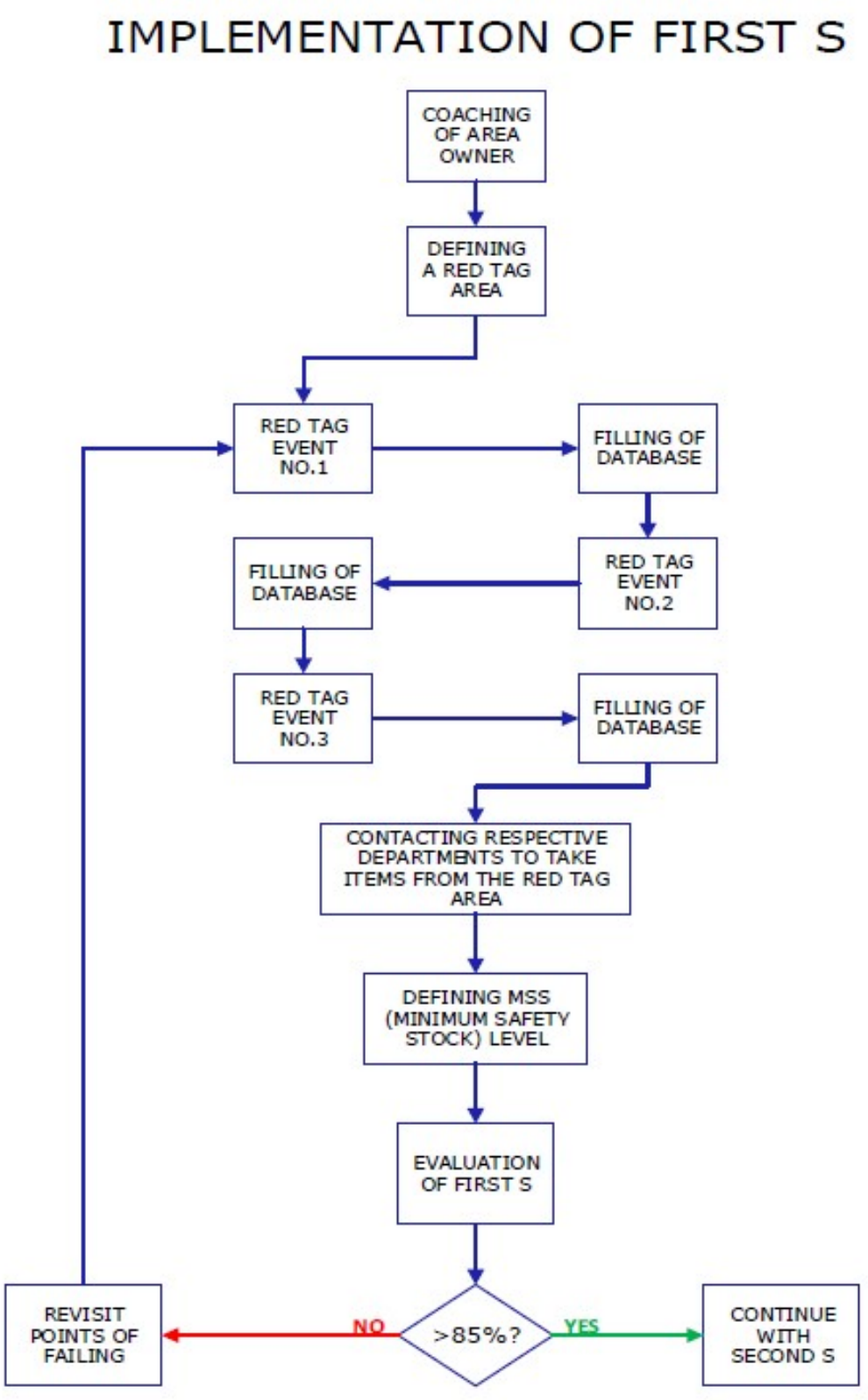


Figure 6 Process flow diagram for implementation of first S.

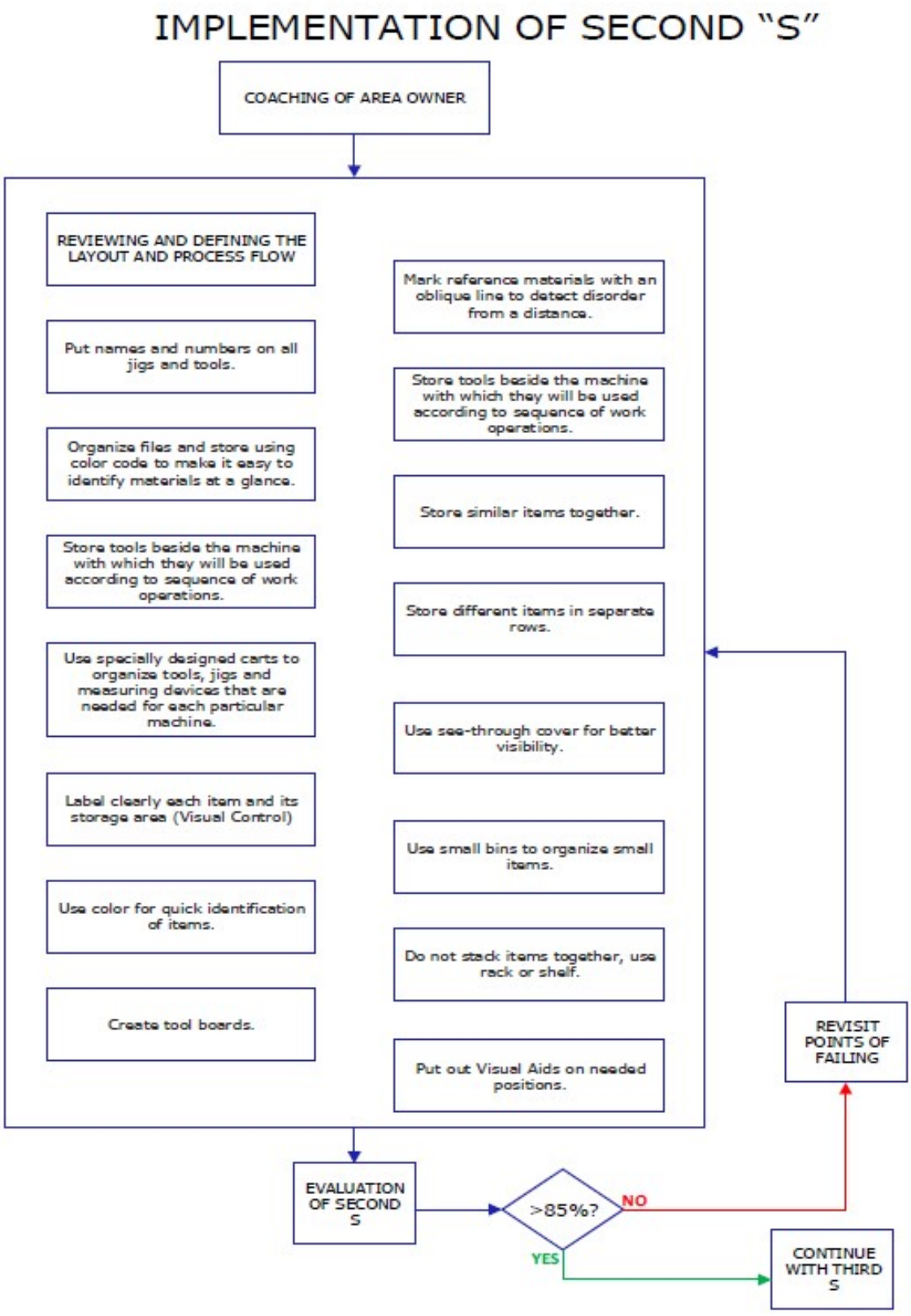


Figure 7 Process flow diagram for implementation of second S.

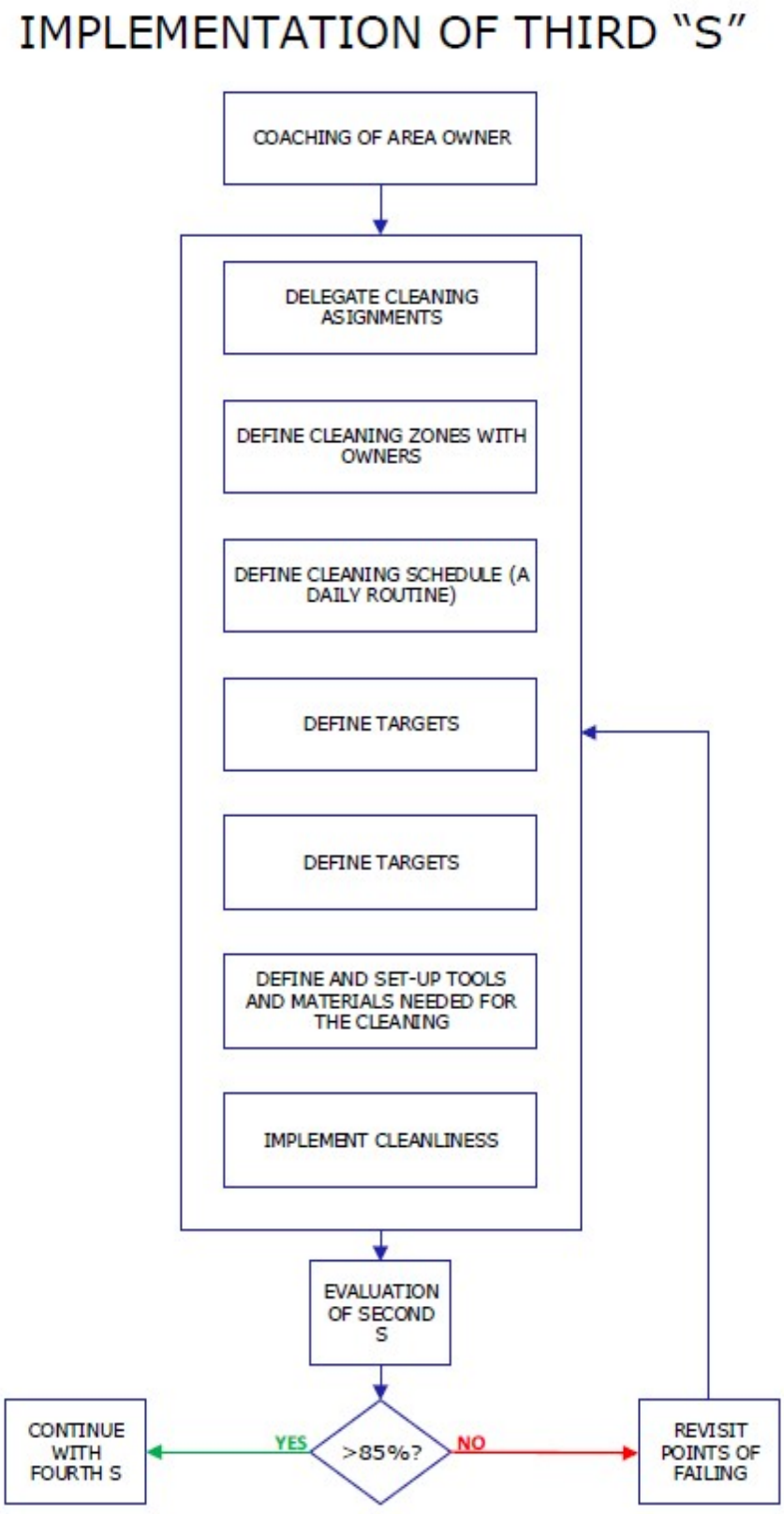


Figure 8 Process flow diagram for implementation of third S.

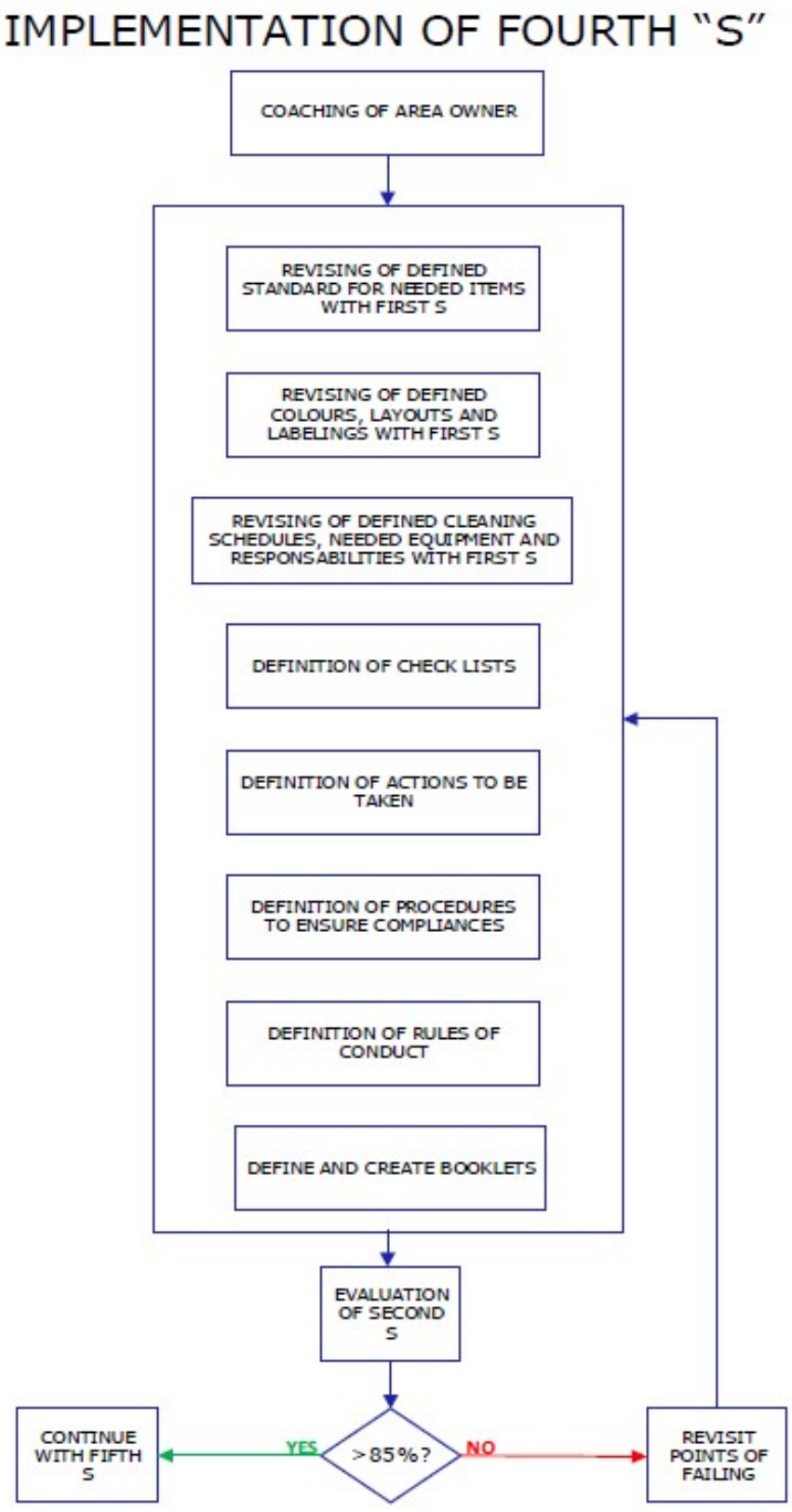


Figure 9 Process flow diagram for implementation of fourth S.

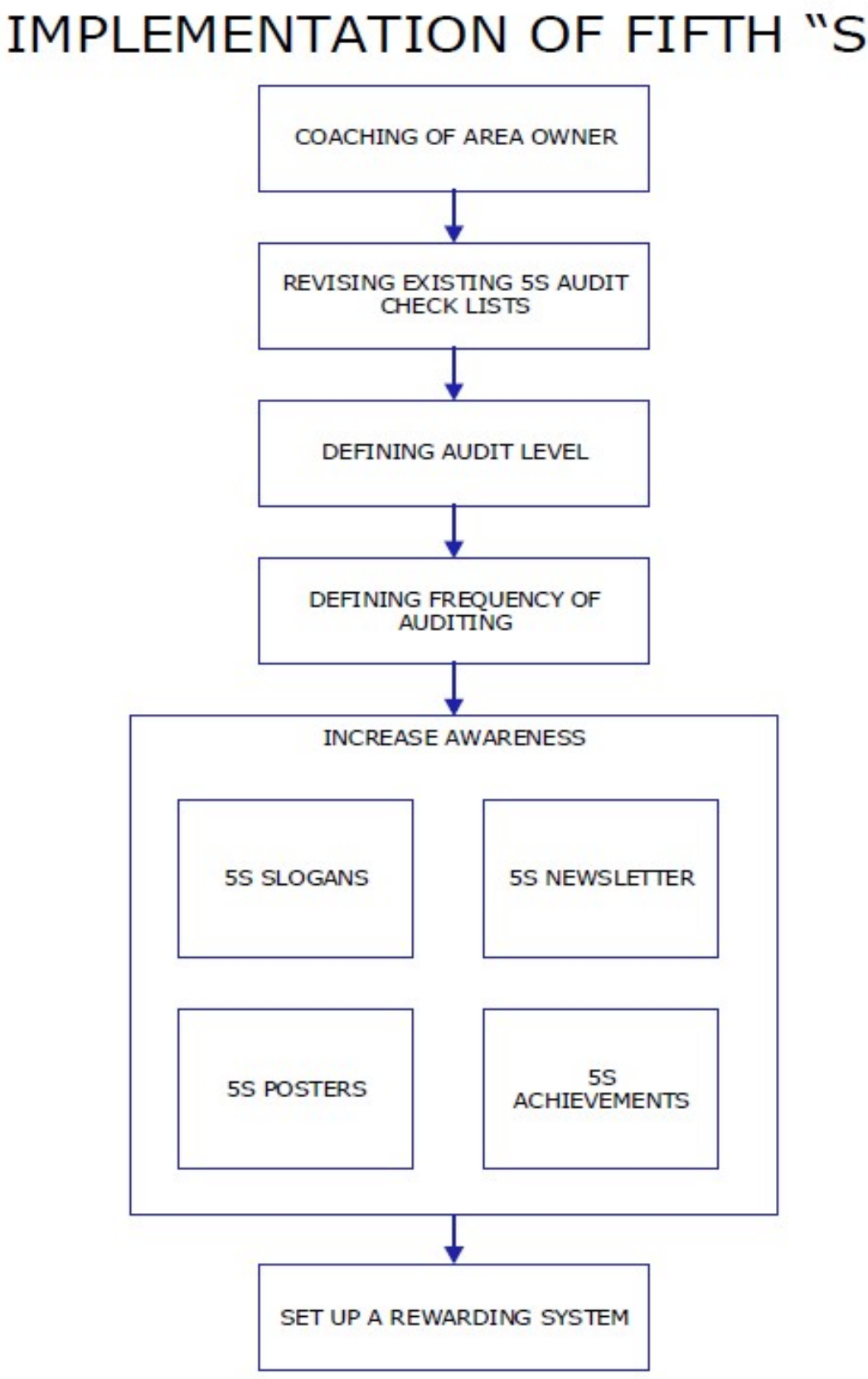


Figure 10 Process flow diagram for implementation of fifth S.

In order to be more understandable, the whole process or all above Process flow diagrams of each 5S steps are included in one Process flow diagram which is showed below:

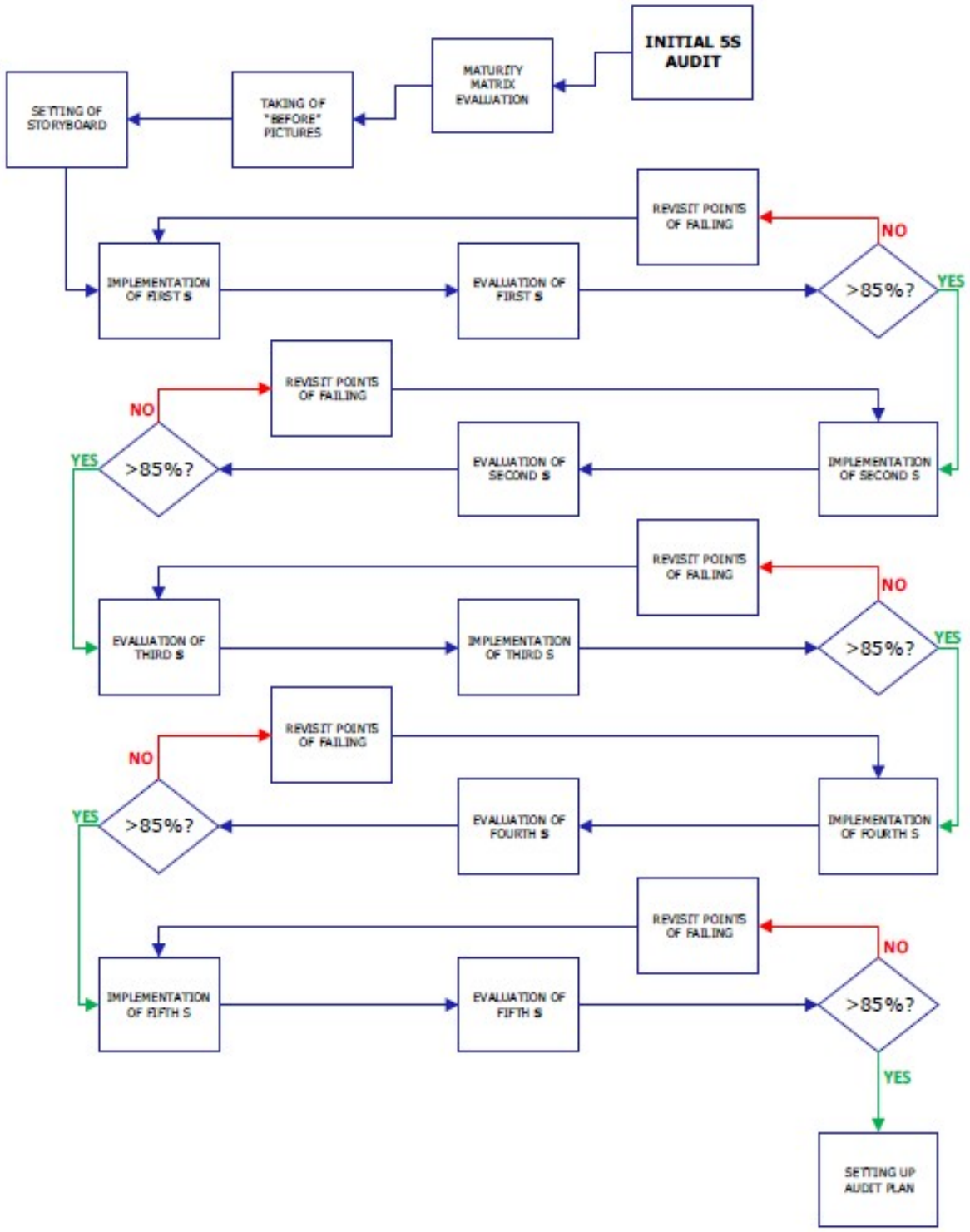
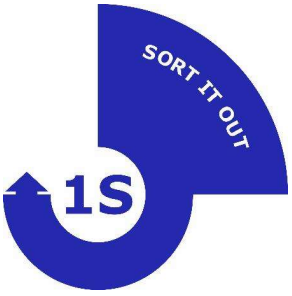


Figure 11 Process flow diagram for implementation of the whole 5S steps.

4.1.4 Implementation of 5S in PGM Tooling Room

Below it is shown the implementation of each 5S step and actions which were taken and completed.

4.1.4.1 IMPLEMENTATION OF "1S" SORT



In order to eliminate all unnecessary items from PGM tooling room which was the outcome target for the 1S the team listed some purposes which were:

- Utilising work space;
- Setting up a standard of which items are needed in the area;
- Preparing the area for the next step – Setting up Visual control and Visual Standards

Initial Cleaning, Red Tagging and separation was done so:

1. Total of 8 pallets of un-needed items were thrashed;
2. Total of 4m^2 of free space was obtained;
3. Safety level increased;
4. Free space on the shelves was obtained;
5. Reduced time for searching for tools and equipment;
6. Furniture was placed to optimise space usage;
7. Teams of 5 people were included in Red Tag Events and
8. Total of 3 Red tag events were raised and each of them lasted for minimum of 4 hours.

Figure 12 Removed unnecessary items.

4.1.4.2 IMPLEMENTATION OF "2S" SET IN ORDER

In 2S, Set in Order, team members come together and share the insights they have gained during 1S and made and assessment of the PGM Tooling room with target to make a work environment which will be high instructive in order to minimize losses and human errors.

Purposes of the second “S” in the case study are listed below:

- Easier management of the area and items;
- Supporting the “Visual Factory” concept;
- Stock control;
- Preparing the area for the implementation of the next step “Cleanliness” and
- Time reducing for searching of needed items.

As a result, the team took some actions:

Firstly, was created a diagram from the current situation with a program for drawing, they shared insights from the 1S, assessed the current situation and created diagram for the future state based on discussions for the opportunities for improvement, elaborated them and then implemented.

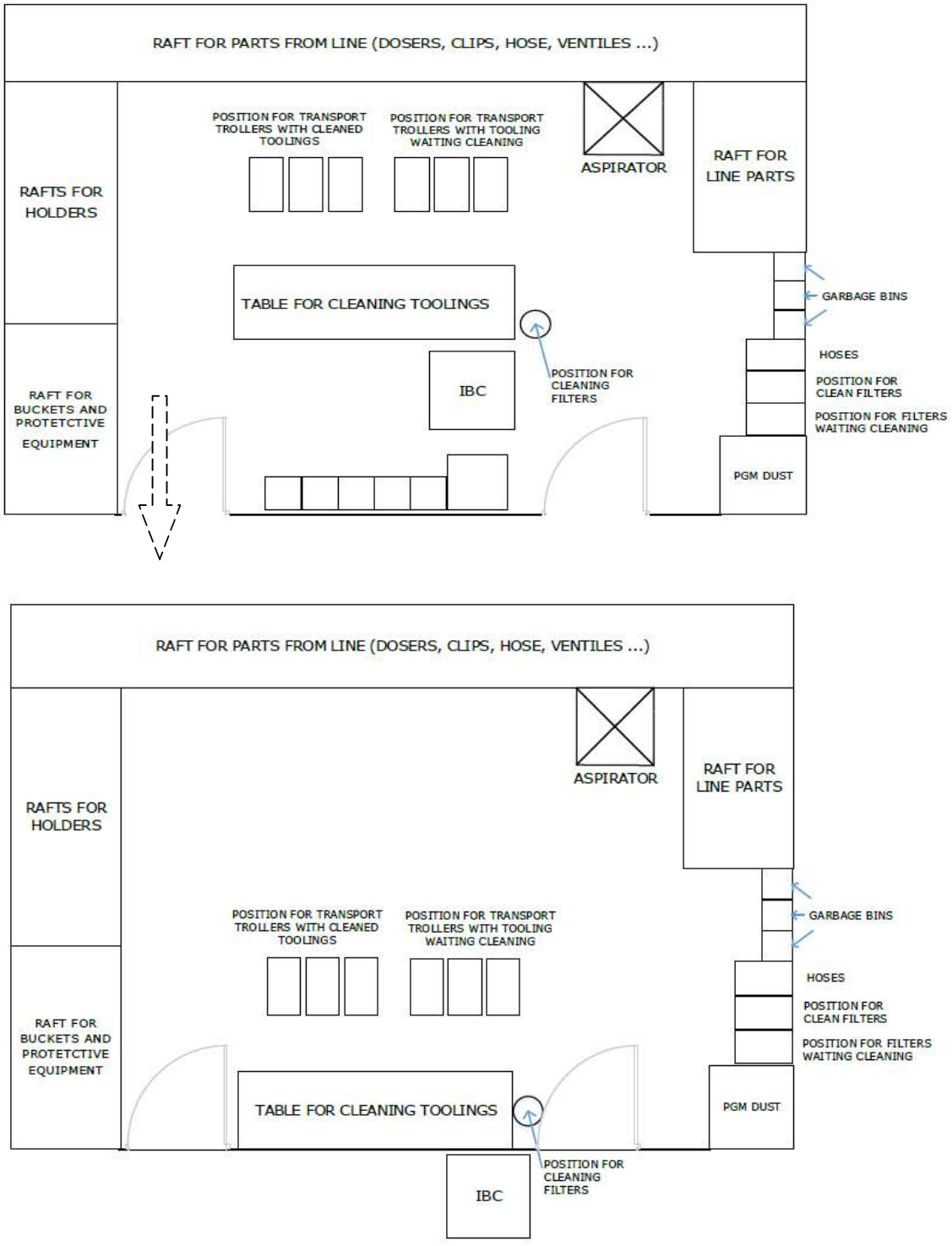


Figure 13 Diagram for defining order system.

Based on the diagram the IBC was removed and pulled out, position for cleaning filters was reallocated form the middle of the room to the wall together with the table for cleaning tooling's, position for transport trolleys with cleaned tooling's and position for transport trolleys with tooling waiting for cleaning were put on the place when the position for cleaning filters was before.

Figure 14 Starting Conditions before 2S.

Figure 15 Situation After Implementation 2S.

4.1.4.3 IMPLEMENTATION OF "3S" SHINE

In the 3S, outcome target was to remove dirtiness, to clean the PGM tooling room and to minimize the contamination sources.

Purpose of the third “3S” SHINE by the team were to:

- Promote Safety
- Easier, faster and safer inspection of the equipment
- Definition of standard for Cleanliness
- Improvements for better overall quality of cleanliness of the tools and equipment

As a result:

- Identification of sources of contamination was done which are shown on the diagram below highlighted with colour such as: positions for filters waiting cleaning, position for transport trolleys with tooling waiting cleaning, and table positions for cleaning filters. Cleaning tasks were completed on the whole PGM tooling room including everything in that workplace.

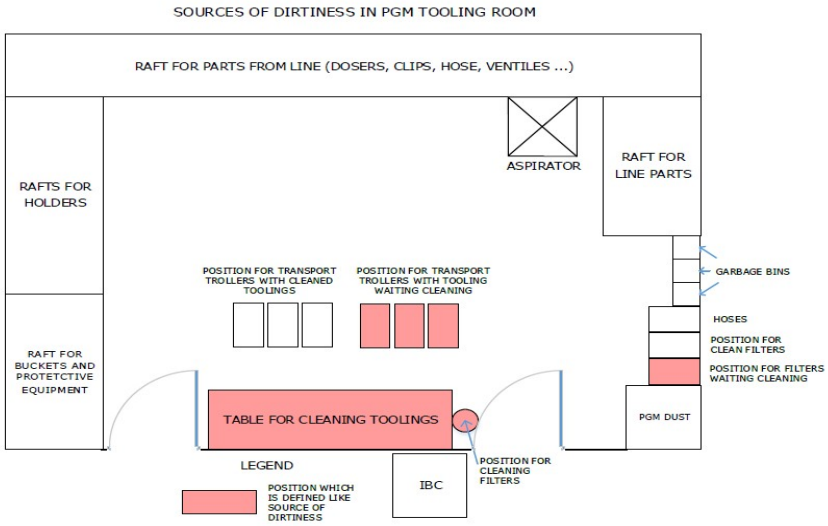


Figure 16 Diagram for Identification source of Contamination.

- Areas of responsibilities for Operators was prepared as a diagram which derived from the origins of identification of sources of contamination. Each operator was defined to be responsible for separate zones in the PGM Tooling Room in very clear manner.

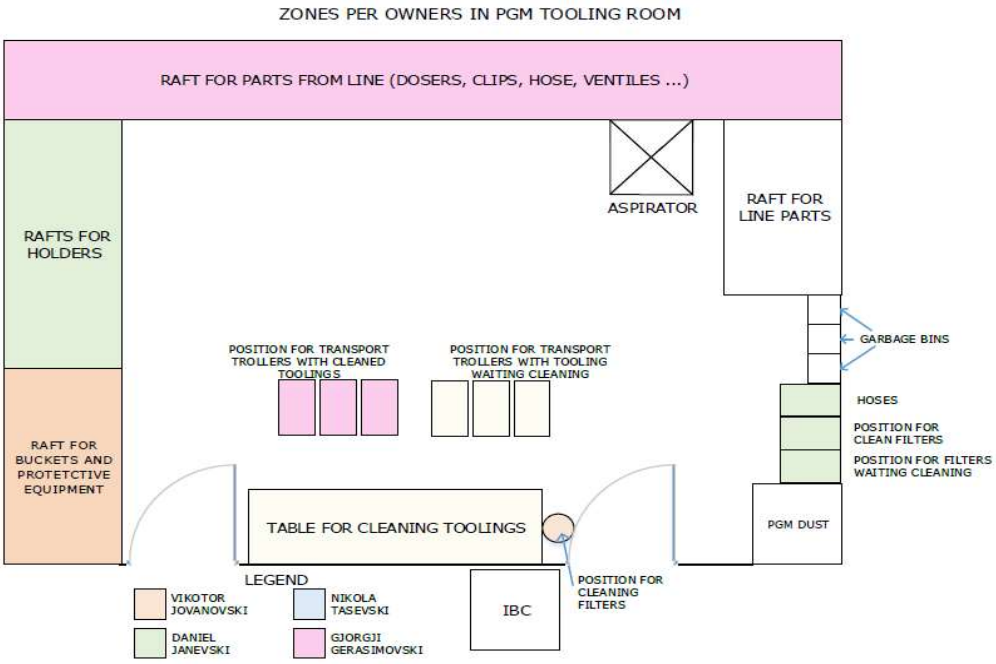
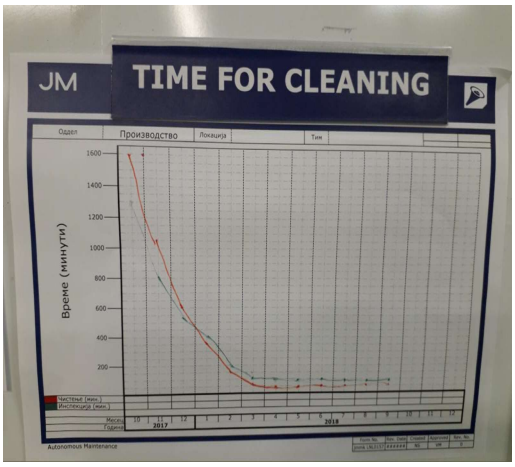


Figure 17 Diagram for areas of responsibilities.

- Monitoring of the time used for cleaning was reduced and also time for inspection.



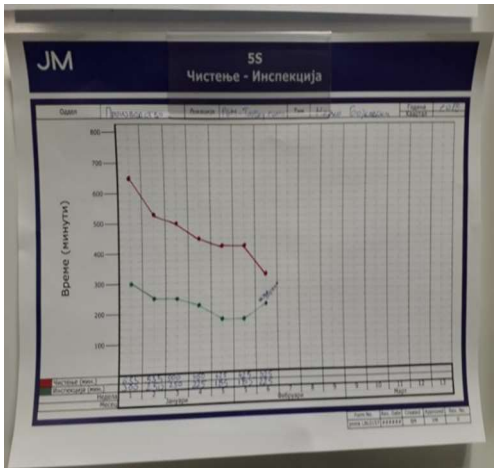


Figure 18 Forms for Monitoring Time for Cleaning and Cleaning Inspection.

- Kaizen has been created for better, faster and easier cleaning of filters from the line. Exactly, the time for cleaning before 5S was 149 min and after 5S Improvements exactly, reallocating the washing station and receiving the new furniture time for cleaning was reduced in 19 min.

Figure 19 Chart of time for cleaning through weeks.

4.1.4.4 IMPLEMENTATION OF "4S" STANDARDIZE

During this phase of implementation, the team identified standards in order to maintain the 5S improvements. Outcome target was to find mechanisms in order PGM tooling room to be visually instructive with visual aids, to reduce waste and human error, to stay clean and organized.

Team was setting up a Dashboard and there they put everything related to the 5S Project implementation starting from:

1. Team (Organogram)
2. Action Tracker
3. Time lost for cleaning
4. Red Tags Raised
5. OPLs (One-point Lessons)

6. Process Flow Diagram
7. Red Tag Database
8. Maps
    a. 8.a Material Flow
    b. 8.b Origins of filth
    c. 8.c Area of responsibilities
9. Visual Aid (First step of Standardization)
10. Visual Representation of future inventory
11. Before and After pictures

Figure 20 Dashboard.

Standard process flow was created which shows the flow of materials, equipment and work process in PGM Tooling room in order to communicate with every employee invloved in this place.

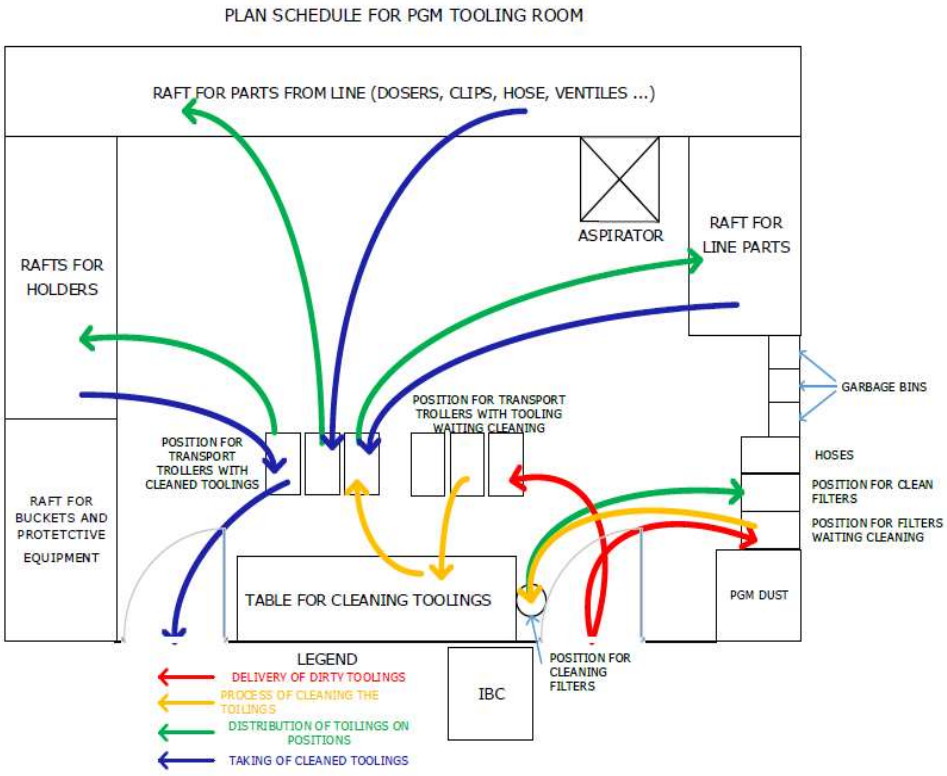


Figure 21 Process flow for PGM Tooling Room.

- Order system via position tagging and visual connection has been done with OPL explanation of positions. Also, training was conducted for One Point Lesson. All visual aids were prepared from side of Lean Department.

Figure 22 One Point Lesson.

- Minimum safety stock has been defined for consumables (e.g. for Personal Protective Equipment)

Figure 23 Minimum safety stock.

- Visual definitions of each S were placed on the wall in order to reminder anytime the employees for the importance of 5S and what they need to do in order to maintain the standards.

Figure 24 Visual definitions for each S.

4.1.4.5 IMPLEMENTATION OF "5S" SUSTAIN

The purpose of S5-Sustain is to maintain standards from previous steps from 4S. The outcome target is to raise a system that will automatically restore order in the workplace and it improves continuously.

Related to the case study form for 5S audit was filled everyday by the Operator before starting the shift and Supervisor was checking if the tasks defined were completed regularly or not, if the operators were trained as per the last procedures or one-point lessons etc.

If the criteria was done as requested it was highlited with green if not with red color.

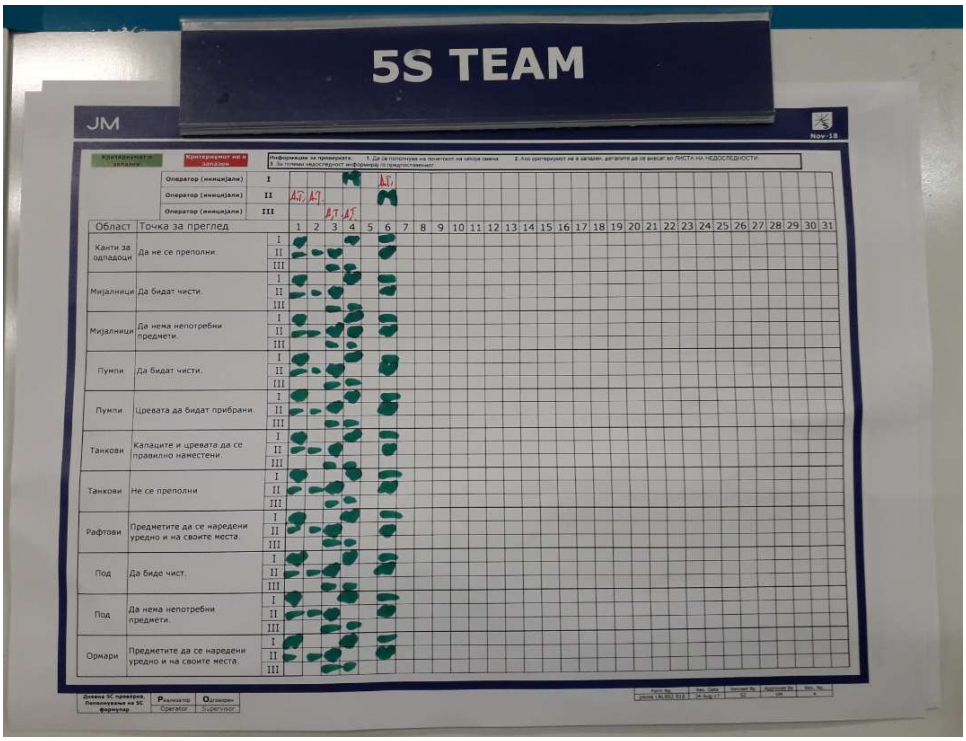


Figure 25 Form for 5S Audit.

In Johnson Matthey on the company level was implemented a software system for 5S Audits which was maintained from Lean Department. Every employee in their yearly objectives had to do 5S audit in monthly basis also the Management.

Figure 26 Software for 5S Audit.

Weekly follow-ups on actions defined.

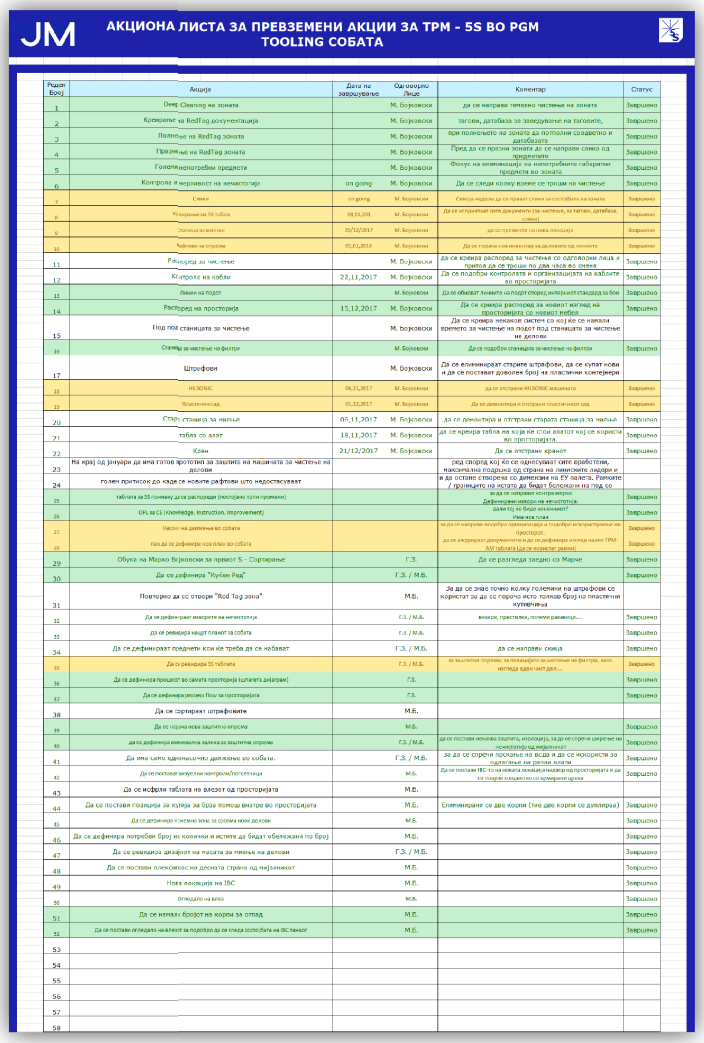


Figure 27 Action Tracker for Implementing 5S in PGM Tooling Room.

4.1.5 Implementation of KAIZEN in PGM Tooling Room

Kaizen in Johnson Matthey also was covered with a procedure and was applied to all JM staff. It was organized in such a way that every employee who want, can proactively implement changes with primary goal of solving individual and team related problems in each area. Employee who wants to do improvement should put that in writing using the form for Kaizen, describing details of the improvement, estimated cost and estimated benefit.

Before the improvement idea starts to implement, it should be approved by the direct manager (supervisor, shift leader) within 1 shift after receiving them and provide feedback to the employees on possibility of its implementation or rejection with reasons. After completion, the Kaizen owner Manager together with the employees have to fill annual savings at the back side of the kaizen form (e.g. safety improvements, line hours and man hours saving, stock, rejects, consumables, waste, electricity, water, gas etc.). Filled Kaizen forms, from implemented improvements, had to be placed in allocated holders that were placed through the factory or hand-on directly to Lean team and they would archive all saving details in the electronic Kaizen system.

Kaizen projects to be archive in the electronic Kaizen system was necessary to:

- Be fully implemented the improvements;
- Approved from the direct manager (supervisor, shift leader);
- Not pass the time limit of 6 months from the implementation date;
- Kaizen form to be fully filed with all additional questions and proper annual saving calculation.

Kaizens were separated in two groups: Small Kaizen and Big Kaizen based on the difference between savings and the cost of implementation of improvement. For successful implementation, recognition was in the form of Certificate of Appreciation, hand-on from the Kaizen Owner Manager.

Certificates and photos from the hand-on event were displayed on Celebrating Success Boards, located in the canteens, with announcement of benefits from implementation.

To be eligible for an award, Kaizen project must have met the following criteria:

- Must be outside the scope of the employee's normal duties;
- It cannot be implemented without the permission, approval or assistance of a supervisor or others;
- It is related to elimination on some of the 7 wastes;

- It will result in improvements to service delivery, work process flow, and/or cost savings.

A project wouldn't be considered for an award if:

- Covered an issue that has, or is being considered by the company, it is on-going by someone else, or it is given as work task;
- Relates to employee terms and conditions of employment;
- It is addressing an improvement that is expected or required from the employee as part of his/her job;
- It is initiated due to matters which are the results of assigned or contracted auditing, studies, surveys, reviews, or research;
- It is actually a complaint about some aspect of the company, there are no visible benefits to the company, its employees or customers;
- It is only a work request to some other department without active participation of project owner.

KAIZEN projects were voted according following criteria:

- Cost saving and/or benefit generated;
- Man-hours Saving;
- Cost and feasibility of implementation;
- Originality;
- Implementation;
- Degree of impact upon the company.
- Transferability to other areas;
- Hierarchical levels of initiator.

So, in PGM tooling room when implementing the 5S, by the time was prepared a Kaizen for easier, faster and better cleaning of dirty parts (filters for the lines).

Operators on Change Over, PGM Tooling were cleaning manually filters for Washcoat. The idea was for automatic washing instead of manual.

Actions taken were to install a device that by pressing the button automatically for e certain amount of time the filter to be washed. One-point Lesson was prepared in order to train other how it works.

Benefits form the improvement were that no need for operator presence to be while washing the filters, and new standard of clean filters was set.

Number of cleaned filters per shift was 20.

20 (filters) * 2 (min)= 40 min in one shift

40 (min)* 3 (shift)= 120 min per day

120 (min) * 340 (days)= 40 800 minutes yearly or converted in hours 680-man hours yearly were saved with this Kaizen.

JM

Kaizen

Attention: Every KAIZEN that is not filled completely, will be returned to the originating department.

Plan

Team / Person	TEAM B/A.Iliq,Z.Panushkovski,D.Velinovski,M/Bojkovski		
Area	Change Over, PGM Tooling	Date	22-Jan-18

Operators in Change Over, PGM Tooling department, during cleaning filters for Washcoat is necessary to handle with the WAP gun. One operator is obliged in every washing to handle and operate manually with the vapor. Automatic washing of filters is necessary instead of manual washing of the filters.

Estimated Savings		Estimated Cost of implementation	

The improvement originated from:

☐ CCC strip ☐ task from Manager ☐ person / team -> same department (expected)
☐ person / team -> same department (unexpected) ■ person / team -> other department (unexpected)

Supervisor / Manager that approves the Kaizen	Name:	Signature:

Do

Actions taken

With this Kaizen is projected and installed device that by pressing a button automatically, for a certain amount of time, includes the water supply to the "WAP", the "WAP" itself and the engine that spins the spraying in all direction for washing the filters. A dashboard with components for automatic operation of the system is made. An electromagnetic valve on the water line has been installed and the intake hoses in the Spray ball tool are directly connected. Completely wired the new equipment and put into operation.

Check

Benefit from the improvement

There is no need for a permanent presence of the operator while the washing is done, and therefore saving in the workforce. There is a predetermined equal duration of washing of the filters. The WAP machine is automatically put into operation, and after the operation is shut down, it automatically offs. The effect of cleaning the filters with constant automatic washing is visible. The filters are greatly washed during this time without the need for a re-washing. .

Act

Confirmation

Have the relevant procedures been updated (if applicable)?		Has the change been communicated to other users/relevant parties (if applicable)?	
Yes	No	Yes	No

JM **Kaizen**

Note: Please explain how is the saving from this KAIZEN calculated.

Annual Savings

Saved	Comment	Value	
EHS	Avoid possible exposure to water spray during manual washing. From ergonomic side, there is no need for someone for a 2 min to hold pressed vapor hand and to stand next to the machine.		
LineHours			Hours (h)
ManHours	Number of cleaned filters (on average 20 in shift) in 2 min	680	Hours (h)
Stock			Days (Days)
Rejects			Parts
Consumables			€
Waste			Kg
Electricity			kWh
Water			m3
Gas			m3

Details for the annual savings (Comment / picture / evidence for the calculation of the annual savings)	In communicatiion with the operators they showed that in one shift there is cleaning of 20 filters. 20 (filters) x 2 (min) = 40 min in one shift 40 (min) x 3 (shift) = 120 min per day 120 (min) x 340 (days) = 40800 minutes yearly or 680 hours yearly

Confirmation from the Supervisor / Manager	Name: Hristijan Manevski	Signature:

Final cost for implementing the improvement (€)	xxx

Implementation — *During the implementation, was there any cooperation with a contractor / other department / local team?*

☐ just an idea, no implementation ☐ initiator + contractor ☐ initiator + other department

☐ by local team ■ by himself / herself

Tranferability — *Is the ipmrovement transferable to other location (other department / in the factory / in other sites)?*

☐ can't be transferred ☐ can be transferred within same department ■ can be transferred to other departments

☐ can be transfered troughtout the site ☐ can be transferred to other sites

Figure 28 Fulfilled Kaizen form for cleaning filters in PGM Tooling Room.

The process was backed up with a One Point Lesson, which shows very clear how the washing process of filter it works and reduces time for training also.

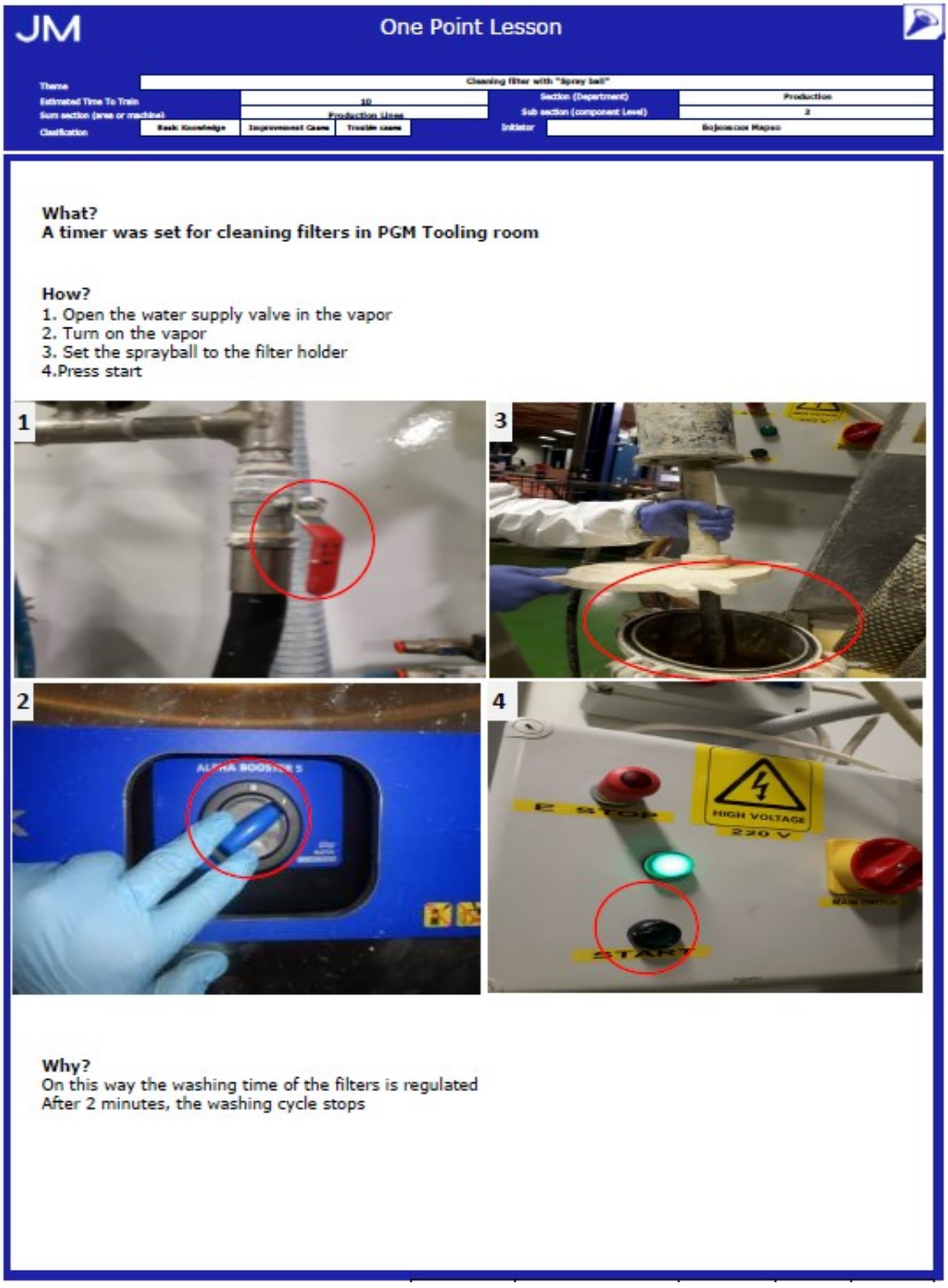


Figure 29 One Point Lesson for Cleaning filters with spray ball.

A standard for “Clean Filter” was made. Below is a picture of cleaned filters before Kaizen and after Kaizen Implementation.

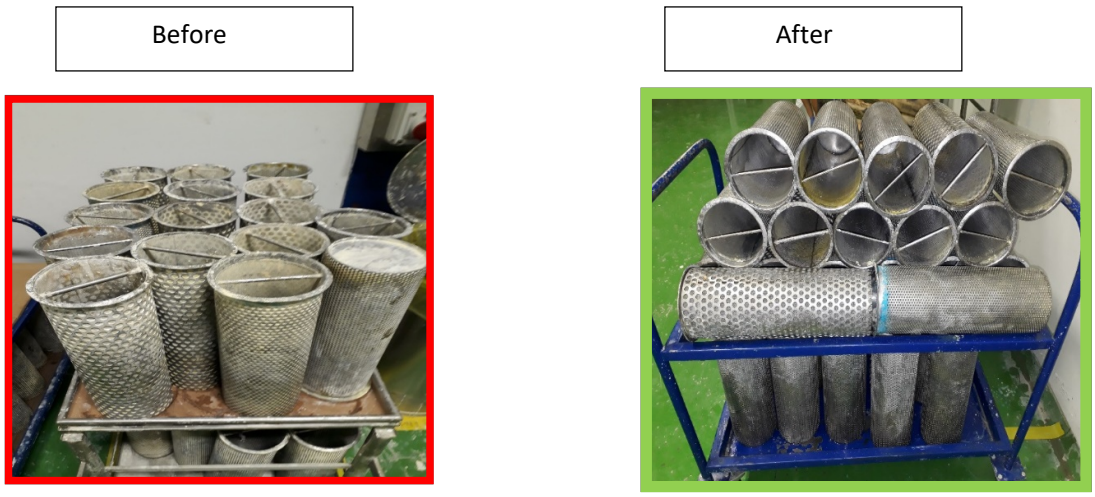


Figure 30 New Standard of clean filters Before and After pictures.

4.2 Data Analysis

This chapter covers the analysis of the data gathered from the observation, case studies above and analysed reports of Lean Department in JM. They are categorized in order to provide summarized comprehensible representation of all data.

Below are represented data from 5S and Kaizen database in Johnson Matthey. Lean department was in charge of collecting data and evaluating Lean Implementation through all JM Skopje Site.

4.2.1 5S Data Analysis

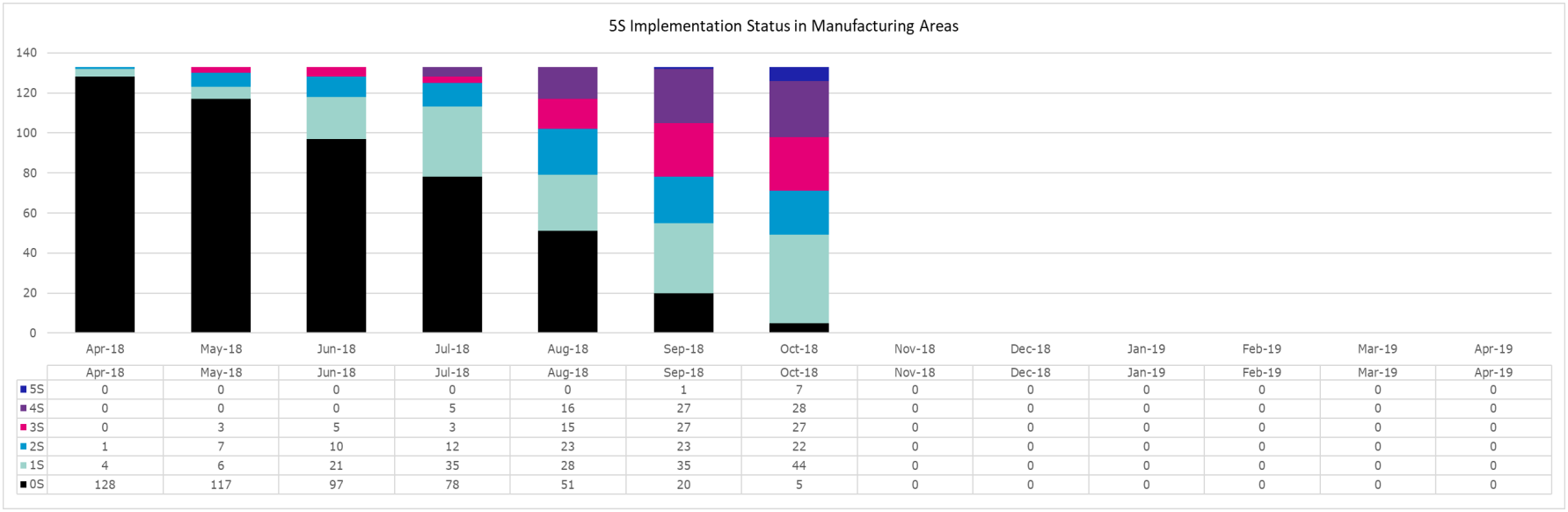
From the 5S case study above, exactly from Figure *19 Chart of time for cleaning through weeks*, after 5S Implementation in terms of Lean it was concluded that the time for cleaning filters before 5S was **149 min** and after 5S Improvements, time for cleaning was reduced in **19 min**.

In JM Skopje Plant 5S implementation project is divided in two separate areas:

- Manufacturing Area
- Administration Area

Below Fig 31 and Fig 32 are showing the status of 5S implementation in monthly and yearly basis on the both areas.

According to the yearly results below for 5S implementation Status in Manufacturing Area we can see that on April were detected I total 133 activities, from which 128 actions with no specific 5S activity in place ,4 activities with Sort implemented and 1 with Sort and Set implemented, which was very poor. As we can see every month after April the 0S activities are significantly decreased and in October we have just 5 activities with 0S and the rest are from different step of 5S. As a result we can conclude that employees in Johnson Matthey have Lean awareness and day after day they are implementing 5S, Lean department is measuring all the results and everyone it is in the same page.



	Apr-18	May-18	Jun-18	Jul-18	Aug-18	Sep-18	Oct-18	Nov-18	Dec-18	Jan-19	Feb-19	Mar-19	Apr-19
5S	0	0	0	0	0	1	7	0	0	0	0	0	0
4S	0	0	0	5	16	27	28	0	0	0	0	0	0
3S	0	3	5	3	15	27	27	0	0	0	0	0	0
2S	1	7	10	12	23	23	22	0	0	0	0	0	0
1S	4	6	21	35	28	35	44	0	0	0	0	0	0
0S	128	117	97	78	51	20	5	0	0	0	0	0	0

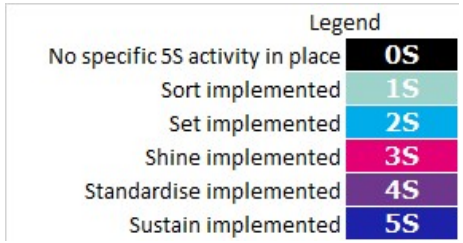
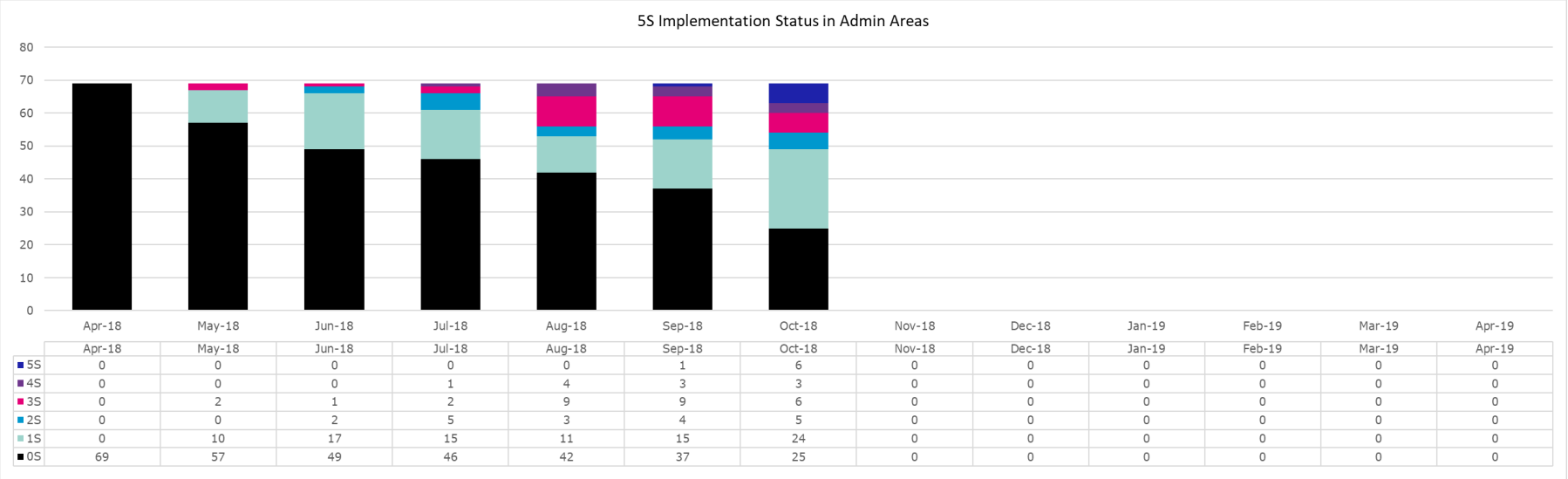


Figure 31 5S Implementation Status in Manufacturing Areas.

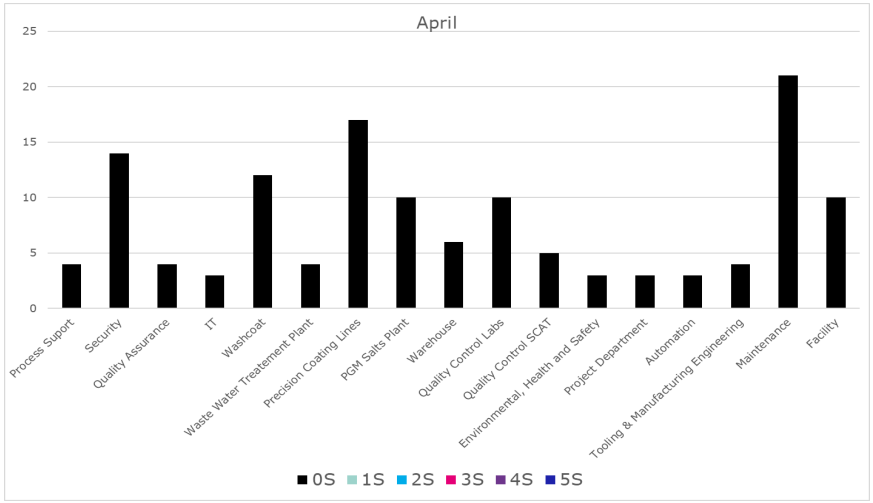
According to the yearly results below for 5S implementation Status in Admin Areas we can see that on April were detected total 69 activities with no specific 5S activity in place. Every month after April the 0S activities are decreased and in October we have just 25 activities with 0S and the rest are from different step of 5S.

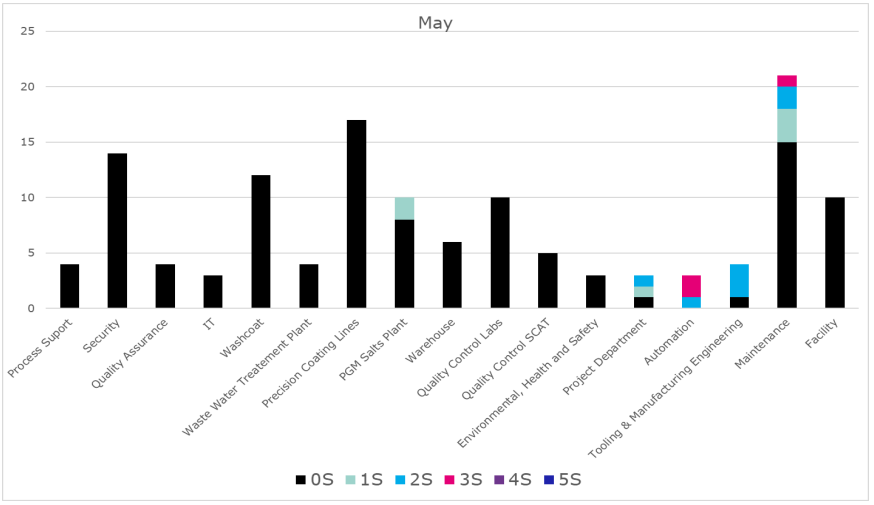


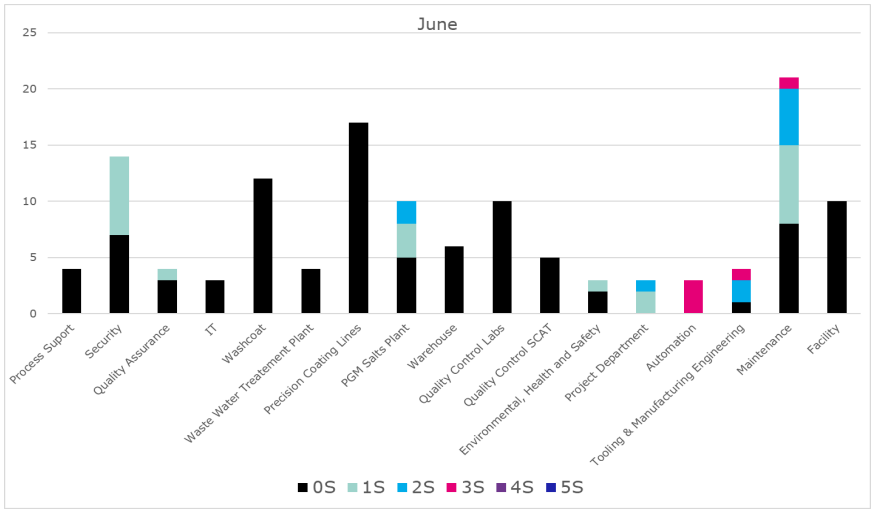
	Apr-18	May-18	Jun-18	Jul-18	Aug-18	Sep-18	Oct-18	Nov-18	Dec-18	Jan-19	Feb-19	Mar-19	Apr-19
5S	0	0	0	0	0	1	6	0	0	0	0	0	0
4S	0	0	0	1	4	3	3	0	0	0	0	0	0
3S	0	2	1	2	9	9	6	0	0	0	0	0	0
2S	0	0	2	5	3	4	5	0	0	0	0	0	0
1S	0	10	17	15	11	15	24	0	0	0	0	0	0
0S	69	57	49	46	42	37	25	0	0	0	0	0	0

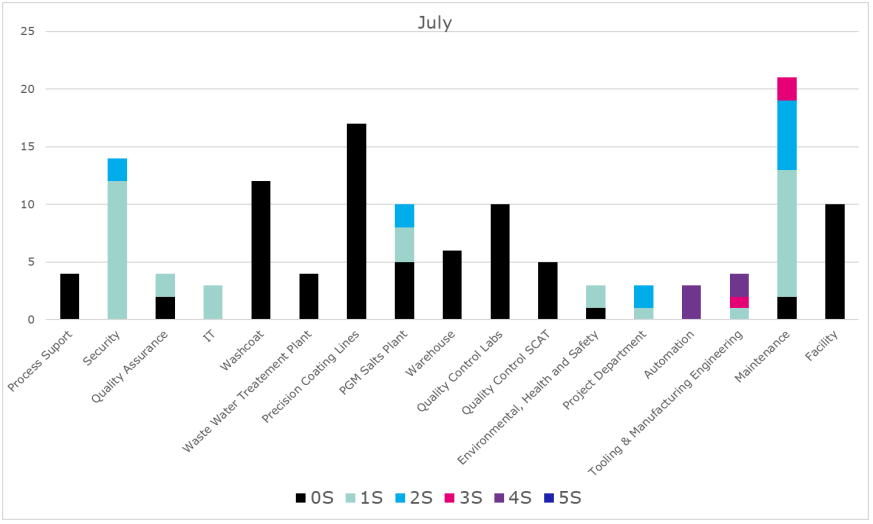
Figure 32 5S Implementation Status in Administration Areas.

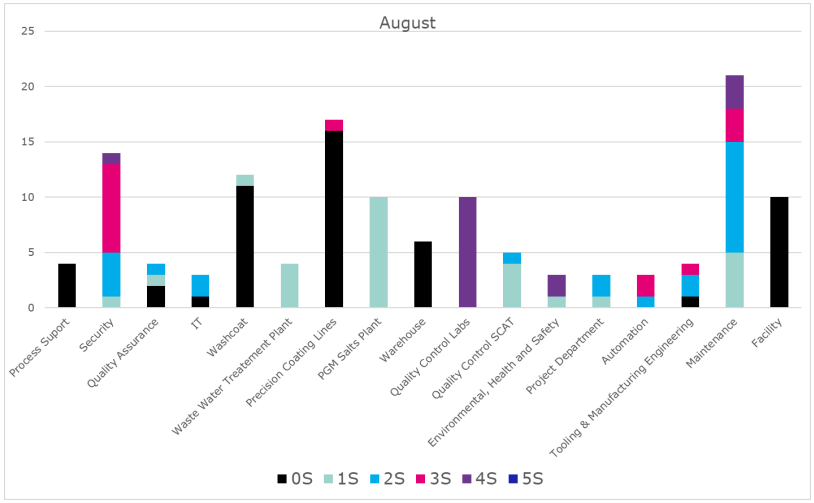
Monthly 5S Status per Department

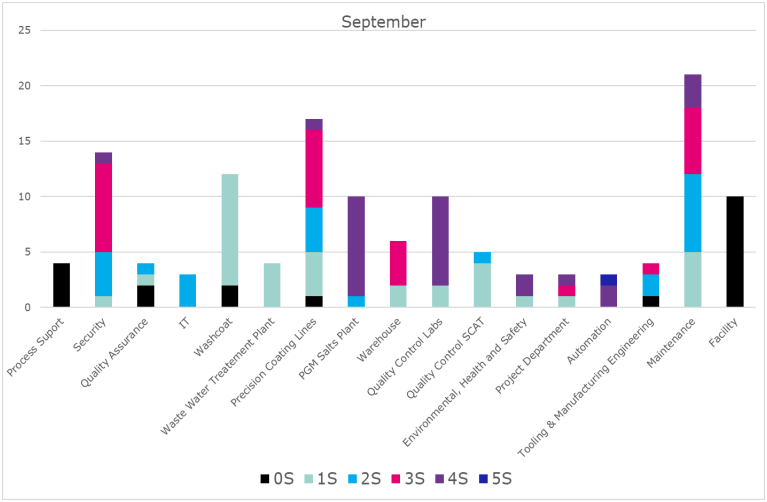












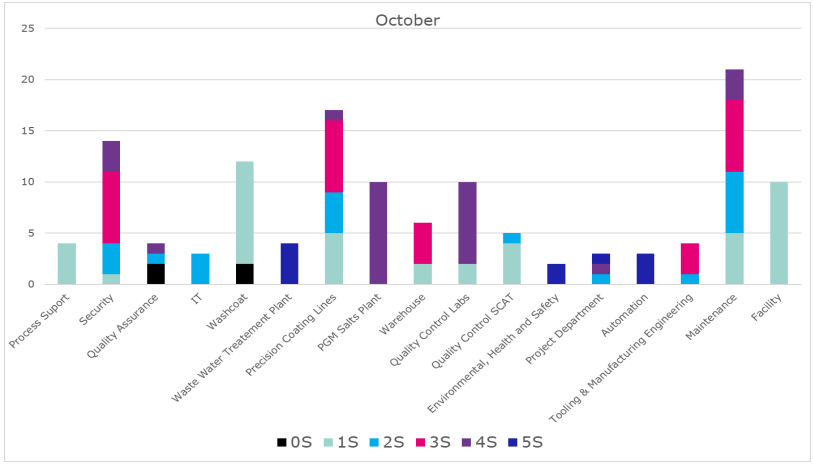
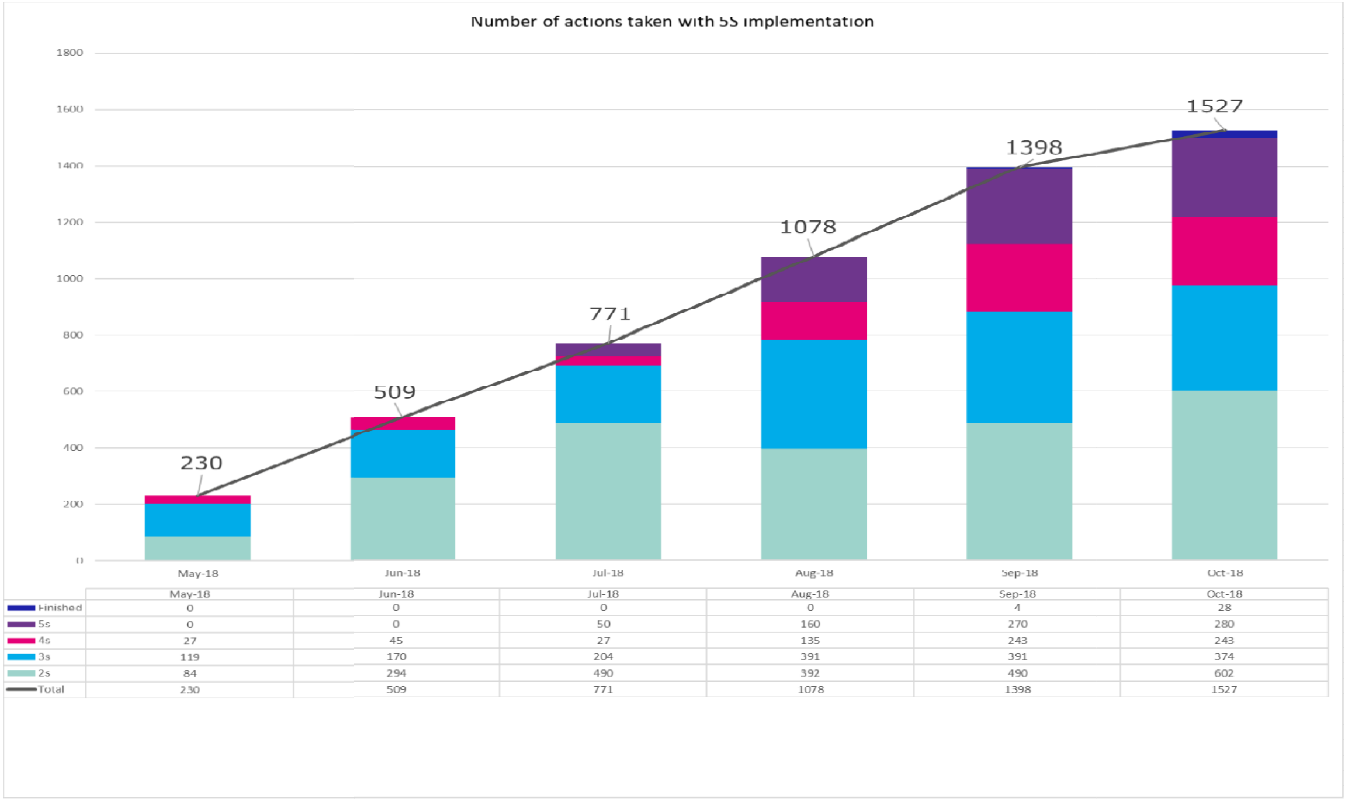


Figure 33 Monthly 5S Status per Department.

From the charts above we can see that in every Department starting from June till October defined 5S projects were close to completed. so they are encouraged to make continues improvement every day.

Regarding the issue how many actions are taken in Manufacturing level below we can see the that in May 230 actions were performed which shows that small group of employees were involved in 5S Implementation process. Every next month the number of actions is quite bigger and in October the total number reach 1527 actions, with 280 5S actions implemented and 28 finished. Which means that awareness and 5S culture is in high level.



	May-18	Jun-18	Jul-18	Aug-18	Sep-18	Oct-18
Finished	0	0	0	0	4	28
5s	0	0	50	160	270	280
4s	27	45	27	135	243	243
3s	119	170	204	391	391	374
2s	84	294	490	392	490	602
Total	230	509	771	1078	1398	1527

Figure 34 Number of actions taken with 5S Implementation.

4.2.2 Kaizen Data Analysis

Also based in Kaizen Case study above in research results, exactly from *Figure 28 Fulfilled Kaizen form for cleaning filters in PGM Tooling Room* as e result, we saw that **680-man hours** yearly were saved with that Kaizen.

Total number of KAIZENs submitted in JM Skopje Plant from beginning till now are 612.

On the fiscal year 2017/2018 is shown that MAX number of prepared Kaizen's is in March with 24 and MIN in August with just 2. In August most of the employees are using summer holidays and for that reason the number of Kaizen is low. On the other hand, in March which is the last month of the FY year, all employees are evaluated for the yearly goals and objectives the number of Kaizens is higher in order to be higher evaluated.

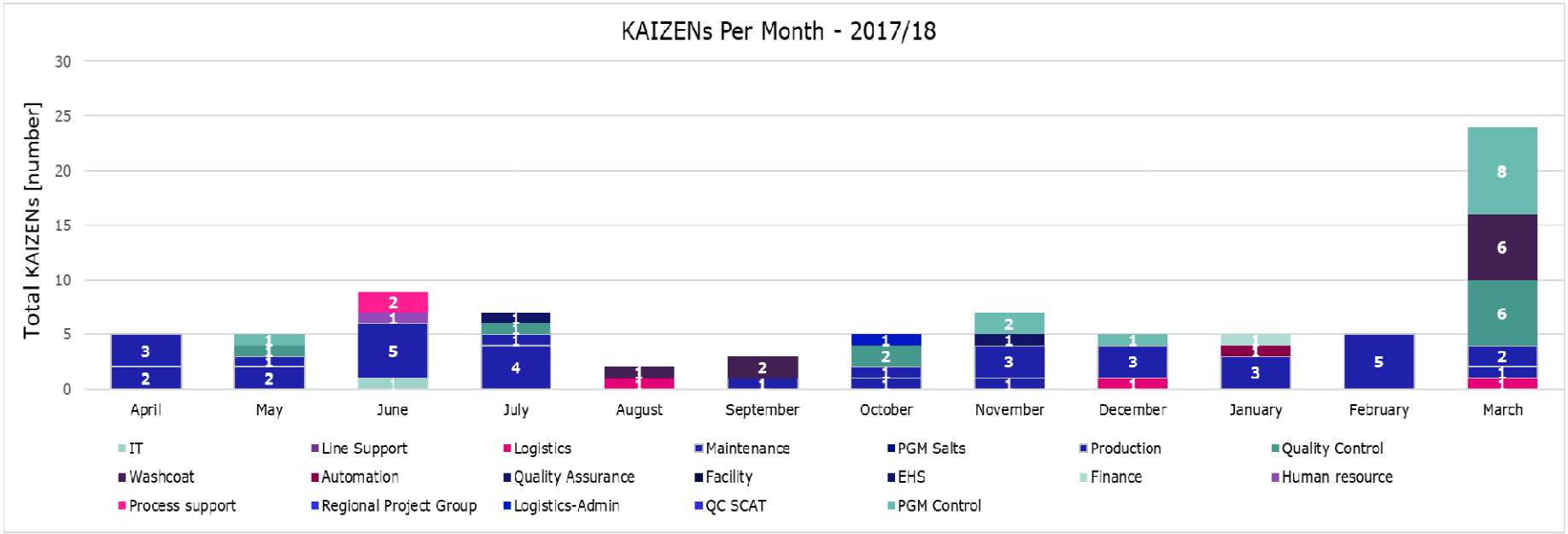


Figure 35 Prepared Kaizens per Month 2017/2018.

On the fiscal year 2018/2019 which is ongoing is shown that MAX number of prepared Kaizen's is in April with 19 and MIN August with just 7.

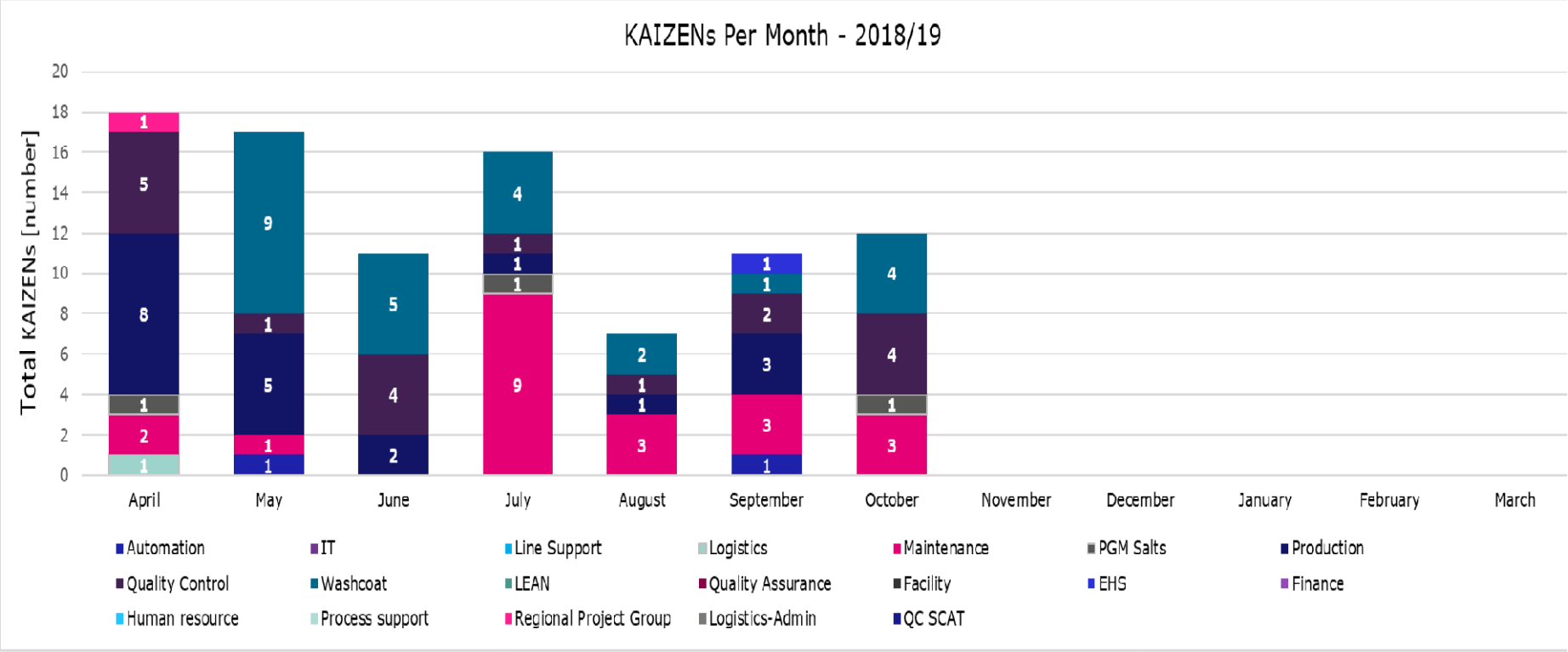


Figure 36 Prepared Kaizens per Month 2018/2019.

If we make a comparison between FY 2017/18 and FY 2018/19 for prepared KAIZENs Per Month we can conclude that:

- In FY 2017/2018 total prepared Kaizens are 82 (12 months)
- In FY 2018/2019 total prepared Kaizens are 84 (7 months till October)

So, number for prepared Kaizen from FY 2017/2018 was significantly increased in FY 2018/2019 with 72%. Which means that awareness and Kaizen culture in JM Skopje it is in high level.

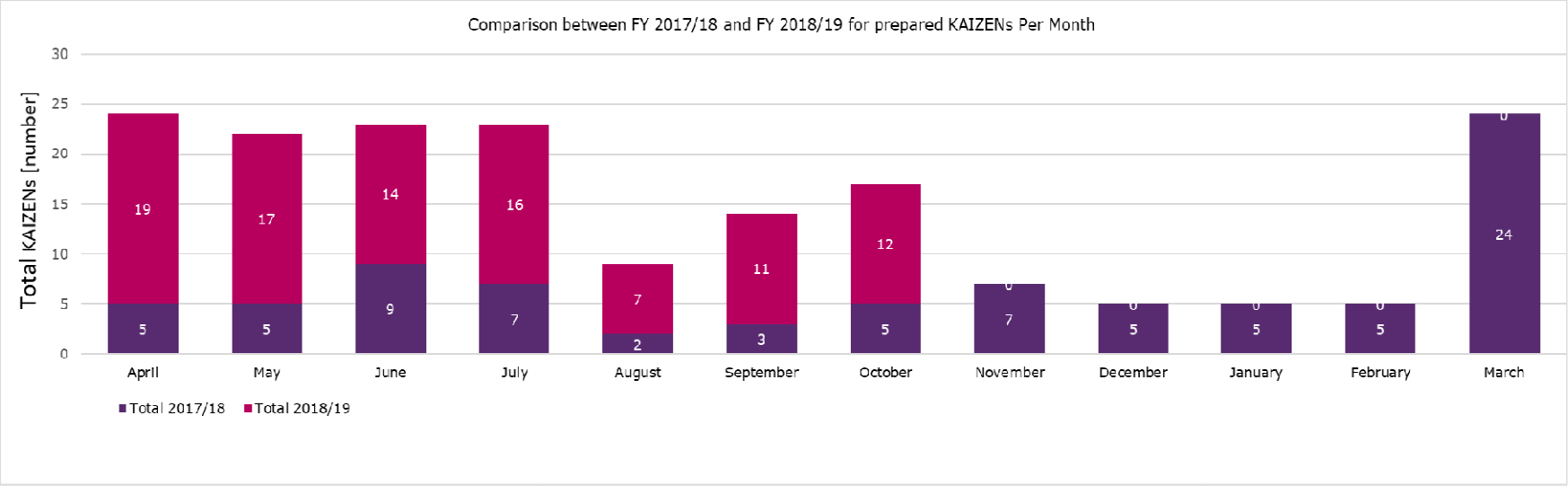


Figure 37 Prepared Kaizens per Month FY 18/19 vs 17/18.

Note: Due to JM sensitive information's, below Kaizen Annual Saving charts are presented in percentage and not in financial value!

So, if we compare Total Kaizen Annual Savings between FY 2017/2018 and FY 2018/2019 is shown that they are increased 16% from FY 2017/2018 to FY 2018/2019.

On the fiscal year 2017/2018 we can see that in June are prepared Kaizen's with bigger Savings of 27 % and in August with 0% and in average for the whole year were 8.42%.

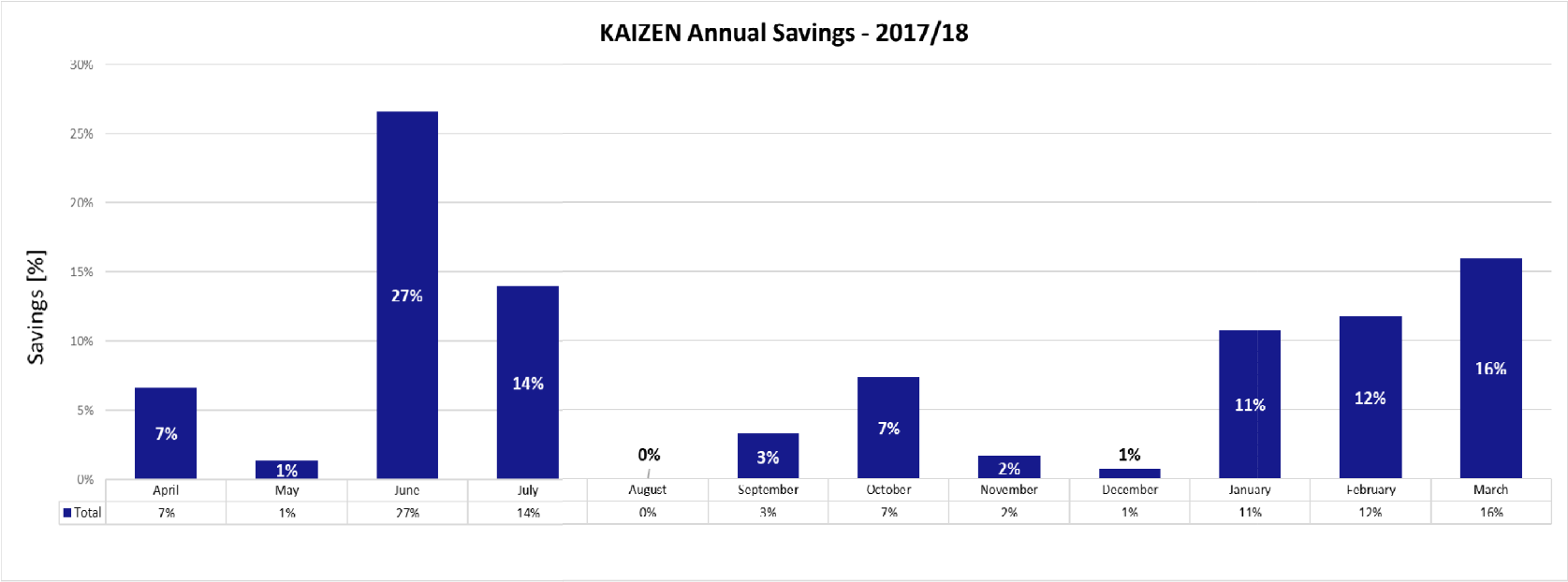


Figure 38 Kaizen Annual Savings FY 17/18.

On the fiscal year 2018/2019 which is ongoing we can see that in May are prepared Kaizen's with bigger Savings of 55 % and in June with 3 % and in average for 6 months were 16.5%

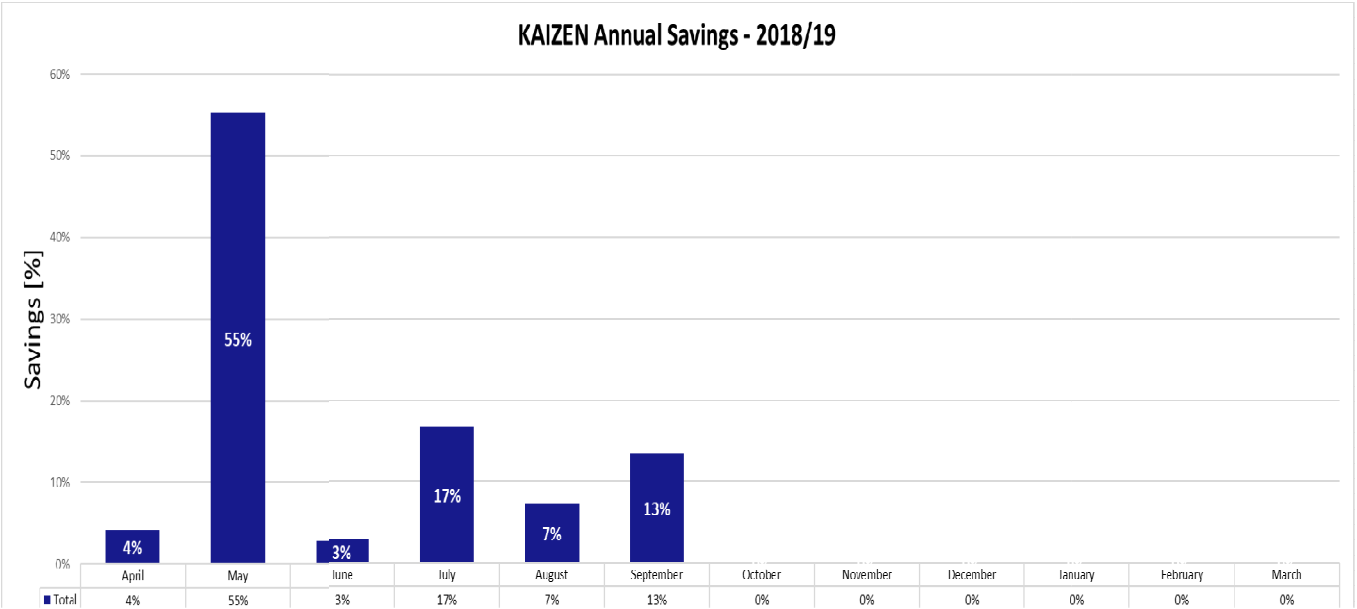


Figure 39 Kaizen Annual Savings FY 18/19.

Regarding to the below chart we can see that in fiscal year 2014/2015 Kaizen Savings per Line hours are bigger in comparison with all other fiscal years. In average per year Kaizen Savings per Line hours were 854-line hours and in total 5 726 for 6 years.

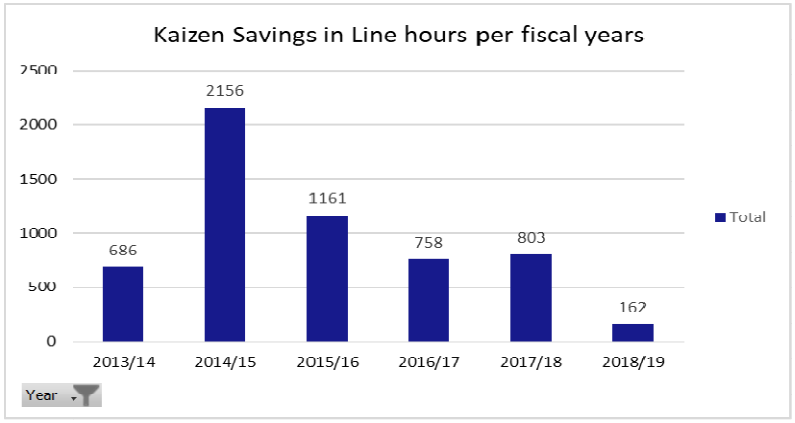


Figure 40 Kaizen Savings in Line hours per fiscal years.

Regarding to the below chart we can see that in fiscal year 2018/2019 Kaizen Savings per Man hours are bigger in comparison with all other fiscal years. In average per year Kaizen Savings per Line hours were 14 723 Man hours and in total 88 338 for 6 years.

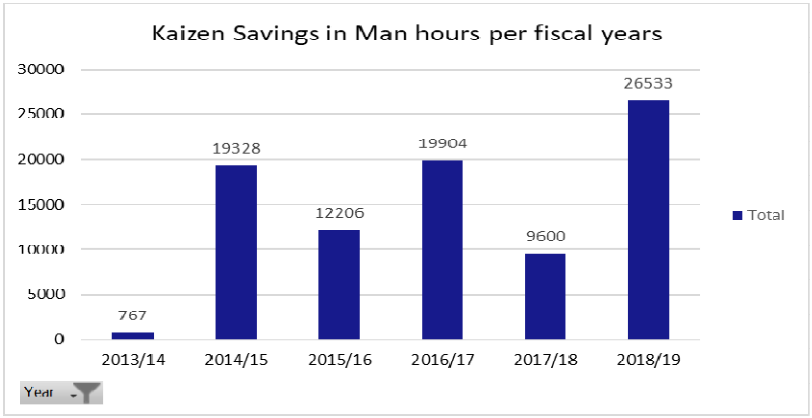


Figure 41 Kaizen Savings in Man hours per fiscal years.

5. HYPOTHESIS

According to our research results and data analysis we conclude hypothesis as below:

H1-Implementing Lean and Kaizen helps reducing time in the work process.

Based on *Figure 19 Chart of time for cleaning through weeks*, presented on the data analysis above. After 5S Implementation as a technique tool in terms of Lean and Kaizen it was concluded that the time for cleaning filters before 5S was **149 min** and after 5S Improvements, time for cleaning was reduced in **19 min**.

Also based on *Figure 28 Fulfilled Kaizen form for cleaning filters in PGM Tooling Room* it is was conclude in PGM tooling room, **680-man hours** yearly were saved with that Kaizen.

Regarding to the *Figure 40 Kaizen Savings in Line hours per fiscal years* we can conclude that total savings in Line hours from FY 2013/2014 till 2018/2019 were **5,726 Line hours**.

Another example that proves the H1 is *Figure 41 Kaizen Savings in Man hours per fiscal years* where we can conclude that Implementing Lean and Kaizen for sure helps reducing time in the work processes and the results are undeniable. Since FY 2013/2014 till 2018/2019 total savings were **88,338 Man hours**.

So, H1 stating that **Implementing Lean and Kaizen helps reducing time in the work process** is proved and confirmed.

H2-Lean and Kaizen help reduce costs and increase savings.

Based *on Figure 38 Kaizen Annual Savings FY 17/18* and *Figure 39 Kaizen Annual Savings FY 18/19.* We can see that in average in FY 17/18 savings were 8.42% and in FY 18/19 were 16.5% (just for 6 months, from April till September).

So, H2 stating that **Lean and Kaizen help reduce costs and increase savings** is proved and confirmed.

H3-Lean Implementation and Kaizen are encouraging employees to be creative and develop a mindset for continues improvements and problem solving.

The intent of the training is to promote a culture of continuous improvement by encouraging employees to be creative in order to make 5S and Kaizen improvements.

Based on *Figure 34 Number of actions taken with 5S Implementation* we can conclude that in one Company where Lean Implementation is well organized and has dedicated team for training employees for Lean culture and following all the actions and advising them. Every next

month the number of actions is quite bigger and in October the total number reach **1527** actions vs starting with just 230 in May, with 280 5S actions implemented and 28 finished. Also, based on *Figure 37 Prepared Kaizens per Month FY 18/19 vs 17/18* we see that number for prepared Kaizen from FY 2017/2018 was significantly increased in FY 2018/2019 with **72%**. Which means that awareness and Kaizen culture is in high level.

So, H3 stating that **Lean Implementation and Kaizen are encouraging employees to be creative and develop a mindset for continues improvements and problem solving** is proved and confirmed.

6. CONCLUSION

This research aimed to identify the positive effects from the Lean Implementation with particular emphasis of Kaizen in Lean. Also, with this study, it is aimed to answer the research question, which was *"Which benefits could a company gain when implementing Lean Manufacturing?"* Based on the data analysis and the review above we came to the conclusions below:

- When Implementing Lean with tools and techniques elaborated in this research such as Kaizen, 5S, Visual Management and Standardized work, a company can gain a lot of positive effects starting from improvement of efficiency in terms of reducing time in work processes, reducing costs and increasing savings in man hours, line hours etc., improving employee's satisfaction, waste elimination and a lot of other benefits mentioned on this research.
- In terms of employees this research proves that Johnson Matthey has instead experience, when employees are more involved with their work. Everyone has the power to contribute and influence on the company performance, they are encouraged to participate in waste reduction through continuous improvement. Kaizen and 5S activities which were suggested and implemented have raised significantly and this have made the work environment much better which we can say that it can guarantee its sustainability.
- The above review indicates that Lean and Kaizen culture focuses on the small steps, continuous improvements, every day better than yesterday. Make the employees to think outside the box with a problem-solving mindset to find the root cause of the problems and take the right countermeasure activities by proper understanding the practices of lean concept which it is crucial.

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