**Open University of Cyprus**

***Faculty of Economics and Management***

**Master *of Business Administration***

# Master's Dissertation

**Optimizing Maintenance Processes in a Beer Production Company**

**Panagiotis Gatzias**

**Supervisor**

**Dr Paris Cleanthous**

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**Open University of Cyprus**
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## Master Thesis

# Optimizing Maintenance Processes in a Beer Production Company

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## Summary

In the dynamic landscape of the brewing industry, where intricate production processes meet rising consumer demands, the effective management of maintenance processes is pivotal for operational efficiency and product quality. This pursuit aligns seamlessly with the objectives of an MBA degree, symbolizing a commitment to mastering skills essential for addressing the challenges inherent in this industry.

This master's thesis is dedicated to the optimization of maintenance processes within a beer production company. By exploring maintenance strategies, techniques, and best practices, it aims to provide actionable insights for brewing industry professionals to enhance their maintenance operations, leading to improved production efficiency and product quality.

The introduction sets the stage by acknowledging the evolving role of maintenance management from basic repair and upkeep to a strategic practice influencing organizational performance. It emphasizes the significance of maintenance in the dynamic world of beer production, where the harmony of artistry and machinery defines the pursuit of brewing excellence.

The thesis identifies a crucial gap in the brewery's operational landscape—a lack of a standardized preventive maintenance program. Operating with an ad hoc and reactive approach, the brewery faces challenges in downtime, competitiveness, reputation, and resource allocation. The goal is clear: to transform maintenance practices by instituting a structured preventive maintenance program that anticipates and prevents equipment failures.

The consequences of the current maintenance approach are multifaceted, impacting not only finances but also production rhythm, competitiveness, reputation, and safety. The vision is to create a future where maintenance is proactive, machinery is under control, equipment failures are foreseen, production flows smoothly, and product quality consistently meets the highest standards.

The thesis outlines a journey of innovation and practicality, aiming not only to provide improved techniques but a practical tool to organize and prepare preventive maintenance

schedules. This tool is envisioned to grant greater control over equipment, reduce downtime, enhance cost-effectiveness, and elevate the quality of the final product.

The subsequent chapters will delve into the development, functionality, and real-world implications of this tool. Positioned as a blueprint for breweries aiming to modernize their maintenance practices, the thesis signifies a crucial step toward redefining how maintenance is managed, turning challenges into opportunities, and reimagining excellence in beer production. As we embark on this transformative journey, the thesis encapsulates the commitment to operational excellence and innovation within the brewing industry.

# Acknowledgements

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This dissertation stands as a testament to the collective efforts and support from my family, Dr. Paris Cleanthous, and Brewery Cyprus Company. I am profoundly grateful for the collaborative environment that has facilitated the exploration and development of ideas in this academic endeavor.

# Contents

# Chapter 1

# Introduction

The brewing industry, characterized by its intricate production processes and increasing consumer demands, faces continuous challenges in maintaining operational efficiency and product quality. In this dynamic landscape, the effective management of maintenance processes becomes paramount for breweries striving to meet production targets, minimize downtime, and uphold product excellence. The pursuit of an MBA degree represents a commitment to mastering the skills and knowledge necessary to address these challenges effectively.

This master's thesis focuses on the optimization of maintenance processes within the context of a beer production company. Through a comprehensive exploration of maintenance strategies, techniques, and best practices, this thesis aims to provide valuable insights that can empower brewing industry professionals to enhance their maintenance operations, ultimately leading to improved production efficiency and product quality.

In a world driven by complex machinery, critical infrastructure, and advanced technology, the efficient management of maintenance processes stands as a linchpin for the reliable operation of assets and the achievement of operational excellence. Maintenance management, as a discipline, has evolved from mere equipment repair and upkeep into a strategic practice that underpins the smooth functioning of organizations across various sectors. This introduction serves as a prelude to a comprehensive exploration of maintenance management, its significance, and its profound influence on the performance, productivity, and longevity of systems and assets.

In the dynamic world of beer production, the pursuit of excellence is a never-ending journey. To craft the perfect brew, breweries must balance the artistry of brewing with the precision of machinery and equipment. Maintenance plays a pivotal role in this orchestration, ensuring that the machinery remains in prime condition, the brewing process is uninterrupted, and the quality of the final product is consistently exceptional.

As we embark on this thesis, it becomes evident that within the brewery's operational landscape, there exists a notable void—a standardized preventive maintenance program. The absence of a structured maintenance regimen presents challenges and opportunities in equal measure. It is this landscape that we seek to transform and optimize, envisioning a future where maintenance is no longer reactive but anticipatory, where downtime is minimized, and the quality of our product is upheld.

Currently, the brewery operates with a maintenance program that can be best described as ad hoc and primarily reactive. Maintenance activities are triggered by breakdowns, malfunctions, and often at the expense of valuable production hours. While the brewing team's artistry is unwavering, the absence of a well-defined preventive maintenance program has, at times, left us at the mercy of unpredictability and equipment failures.

The consequences of this maintenance approach are multifaceted. Downtime, as we well know, is not solely a financial burden. It disrupts the rhythm of production, erodes our competitiveness, damages our reputation, and, in certain circumstances, even poses safety risks. Resources are allocated reactively, leading to inefficiencies and unnecessary costs. It is a scenario that, in the long run, is neither sustainable nor conducive to the operational excellence we strive to achieve.

Our goal is clear—to transform the brewery's maintenance practices and institute a well-structured preventive maintenance program. We envision a future where maintenance is a proactive and anticipatory endeavor. This future is not only within reach but entirely achievable. It is a future where the brewery operates with the confidence of having control over its machinery, where equipment failures are foreseen and prevented, where production flows smoothly, and where the quality of our product consistently meets or exceeds the highest standards.

To realize this vision, we set forth on a journey of innovation and practicality. This thesis is a testament to our commitment to bridge the gap in the brewery's maintenance program. We aim to provide not only improved techniques but a practical tool that will organize and prepare the preventive maintenance schedule. With this tool, we will achieve greater control over our equipment, a reduction in downtime, enhanced cost-effectiveness, and ultimately, an elevation in the quality of our product.

The subsequent chapters of this thesis will unveil the development, functionality, and real-world implications of this tool. It is a step forward in our quest for operational excellence, and it serves as a blueprint for breweries seeking to modernize their maintenance practices. The journey begins here, as we set out to redefine how maintenance is managed, transforming challenges into opportunities, and reimagining excellence in beer production.

# Chapter 2

# Maintenance strategies

## 2.1 What is Maintenance and Why Is It Important?

Maintenance is fundamentally concerned with preserving an asset in optimal working condition, allowing it to function at its full productive capacity. This critical function encompasses both upkeep and repair activities. The dictionary succinctly defines maintenance as "the work of keeping something in proper condition," with a broader interpretation being to keep it in a designed and acceptable state, preventing the loss of partial or full functional capabilities. This definition emphasizes the proactive nature of maintenance, aiming to preserve and protect assets. (Ramesh Gulati,2011)

A more comprehensive perspective on maintenance is to "keep from losing partial or full functional capabilities," implying that maintenance includes tasks performed to prevent failures as well as activities aimed at restoring the asset to its original condition. However, contemporary maintenance paradigms introduce a new focus on capacity assurance. In this context, proper maintenance ensures that the capacity of an asset can be realized at its designed level.

For instance, consider the designed capacity of production equipment, which may be specified as producing x units per hour. This designed capacity can only be achieved if the equipment operates without significant downtime for repairs. Hence, the evolving paradigm of maintenance is closely tied to capacity assurance, emphasizing the importance of ensuring assets operate at their full potential. This includes preventative measures to avoid failures and corrective actions to restore assets to their original condition.

In summary, maintenance extends beyond mere repairs; it is a proactive strategy aimed at preserving assets, preventing failures, and, crucially, assuring that assets operate at their intended capacities. The next sections will delve into specific methodologies and frameworks employed in maintenance practices and their implications for operational excellence. (Ramesh Gulati, 2011).

## 2.2 Literature Review

Maintenance is a critical aspect of ensuring the prolonged functionality of equipment throughout its productive life (Bann, 1997). Regular maintenance schedules are planned to guarantee that equipment remains available, meeting production specifications and requirements. Maintenance encompasses functional and operational checks, servicing, and the replacement of necessary devices, machinery, and infrastructure in industrial settings, with the aim of preserving the equipment in its original condition. This involves the development of comprehensive documentation to ensure consistent and proper execution of these tasks.

In industrial contexts, the role of maintenance has become integral to overall organizational profitability, significantly influencing competitive advantages in the global market (Steve Krar, 2008). The effectiveness of lean manufacturing processes is closely tied to the implementation of maintenance practices, aiming to minimize waste and ensure continuous operational efficiency. The importance of frequent maintenance cannot be overstated, as it proves more cost-effective than addressing severe breakdowns that halt production.

The primary objective of routine maintenance is to ensure that all production-related equipment operates at maximum efficiency consistently. Through daily inspections, lubrication, cleaning, and minor adjustments, potential issues can be identified and addressed before they escalate into significant problems that could disrupt the entire production line. A successful maintenance program requires full support from all levels of management, emphasizing its role in meeting legal requirements related to safety and occupational health (Sappi, 2001).

Furthermore, maintenance is crucial in preventing premature wear and tear of plant and equipment. Early deterioration due to inadequate maintenance has cost implications associated with equipment replacement. Implementing a meticulous maintenance program can extend the lifespan of equipment, minimizing repair costs. Effective maintenance practices also enable timely repairs, preventing uncontrollable failures and potential revenue loss.

In contemporary industries, keeping machines well-maintained is paramount (Dowler, 2015). Although the application of stretch film may seem straightforward, regular, scheduled maintenance for stretch wrap devices is essential. Without routine check-ups, critical parts of the machine may fail, leading to costly and time-consuming repairs. Neglecting maintenance can jeopardize the functionality of equipment crucial to an organization's use of binding film, emphasizing the importance of regular inspections and upkeep.

Cignifican also is Total Productive Maintenance (TPM), defined by Nakajima (1988), stands as a comprehensive plant improvement methodology, fostering continuous and rapid enhancements in manufacturing processes. At its core, TPM relies on employee involvement, empowerment, and closed-loop measurement of results. Imai (1986) offers an additional perspective, describing TPM as a holistic approach aiming to maximize equipment effectiveness through a total system of preventive maintenance. This inclusive strategy involves all departments and levels, motivating collective engagement in plant maintenance activities. (Ayman Bahjat Abdallah,2013)

In conclusion, the literature underscores the multifaceted significance of maintenance in industrial settings. From ensuring operational efficiency and safety to minimizing costs associated with premature equipment failure, effective maintenance practices are integral to the success and sustainability of modern manufacturing processes. The next sections will delve into specific methodologies and frameworks employed in maintenance practices and their implications for operational excellence. (Khathutshelo Mushavhanamadi and Brian Tumiso Selowa , 2006)

## 2.3 Maintenance Management in Brewing Industry

Maintenance management in the brewing industry has witnessed significant changes. Traditionally, breweries employed reactive maintenance practices, addressing breakdowns as they occurred. However, modern breweries embrace predictive maintenance with sensors, bearing vibration analysis, data analytics, and machine learning to forecast equipment failures and prevent disruptions.

The application of reliability-centered maintenance (RCM) principles has gained prominence, allowing breweries to prioritize maintenance efforts on critical assets. The convergence of brewing and technology has led to digitalized maintenance processes that enhance efficiency and minimize downtime.

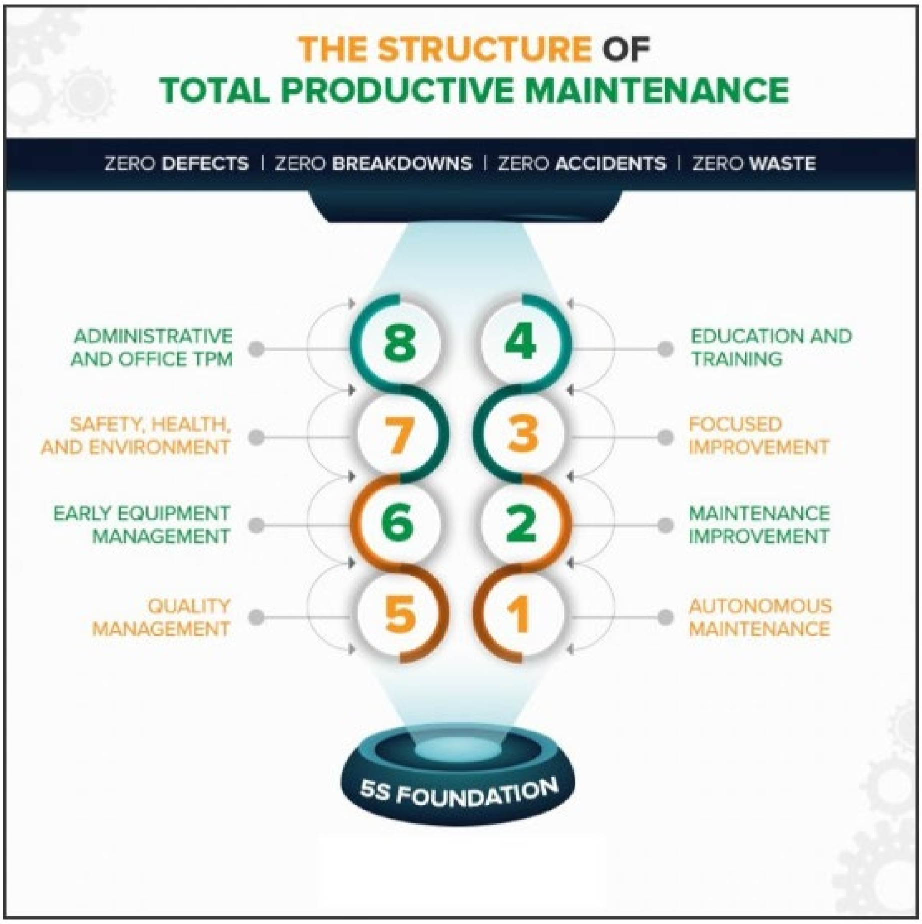
Reliability-centered maintenance (RCM) is the optimal combination of reactive, time-based, condition-based, and proactive maintenance practices. These core maintenance strategies are not employed in isolation but are integrated to leverage their individual strengths, aiming to enhance facility and equipment reliability while minimizing life-cycle costs. Various methodologies such as Total Productive Maintenance (TPM), Total Maintenance Assurance, Preventive Maintenance, Reliability-Centered Maintenance (RCM), and other innovative approaches to maintenance challenges all share a common goal: to improve the effectiveness of machinery, ultimately leading to enhanced productivity.

### Total Productive Maintenance (TPM)

Total Productive Maintenance (TPM) is a crucial approach in modern industrial and manufacturing settings, driven by the pressing need to address the escalating costs associated with downtime. According to Aberdeen Research, the average hourly cost of downtime across all businesses has surged from $164,000 in 2014 to a staggering $260,000. Given that industrial and manufacturing processes predominantly rely on the continuous operation of machinery, mitigating the impact of downtime is imperative.

TPM, in essence, represents a comprehensive strategy that encompasses machinery, equipment, workforce engagement, and supporting processes to uphold and enhance production integrity and system quality. At its core, TPM involves empowering employees to take an active role in the maintenance of their equipment, with an emphasis on proactive and preventive maintenance practices. The ultimate objective of TPM is perfect production, characterized by:

- ✓ **No Breakdowns**
- ✓ **No Stops or Reduced Operating Speeds**
- ✓ **No Defects**
- ✓ **No Accidents**



*Picture 1The Structure Of Total Productive Maintenance (Bryan Christiansen,2018)*

The core objective of TPM is to enhance productivity by minimizing downtime, which, in turn, significantly impacts Overall Equipment Effectiveness (OEE) over time. Within the TPM framework, preventive maintenance takes precedence. The conventional "run it until it breaks" mindset is not a viable option in TPM. Instead, TPM advocates a shift towards making machinery the focal point of operations, with the aim of maximizing equipment availability.

## Benefits of Total Productive Maintenance (TPM)

*Shift from Reactive to Predictive Maintenance*

The adoption of Total Productive Maintenance (TPM) marks a strategic shift from reactive to predictive maintenance. Reactive maintenance, often likened to 'firefighting,' not only incurs substantial costs for machinery repairs but also leads to significant expenses associated with unplanned downtime. TPM introduces a paradigm that transcends mere problem-solving by proactively addressing issues before they escalate, thereby yielding several direct and indirect benefits.

*Increased Productivity*

TPM's emphasis on proactive maintenance practices translates into increased overall productivity. By minimizing unplanned downtime and disruptions, production processes can operate smoothly and consistently, contributing to higher output levels and improved efficiency.

*Reduced Manufacturing Costs*

The implementation of TPM brings about a reduction in manufacturing costs. By preventing unexpected breakdowns and addressing issues at their root, organizations can optimize the utilization of resources, streamline processes, and curtail the expenses associated with reactive maintenance. (I.P.S. Ahuja and J.S. Khamba,2008)

*Reduction in Customer Complaints*

A direct outcome of TPM is a reduction in customer complaints. By ensuring machinery operates reliably and consistently, organizations can meet customer demands with precision, delivering the right quantity at the right time with the required quality. This heightened reliability contributes to increased customer satisfaction.

*Improved Customer Satisfaction*

TPM's commitment to delivering the right quantity at the right time with the best-required quality is instrumental in satisfying customer needs by 100%. This positive impact on customer satisfaction is a crucial benefit that enhances the reputation of the organization in the market.

*Enhanced Safety and Environmental Performance*

TPM not only focuses on equipment efficiency but also plays a pivotal role in ensuring workplace safety and addressing environmental concerns. The reduction in unexpected equipment failures contributes to a safer work environment, reducing safety incidents and environmental risks.

*Positive Work Culture and Employee Confidence*

Beyond tangible benefits, TPM creates a positive work culture and environment. This positive shift builds a higher level of confidence among employees. The emphasis on cleanliness, neatness, and attractiveness of the workplace fosters a conducive atmosphere for optimal performance.

*Employee Empowerment and Knowledge Sharing*

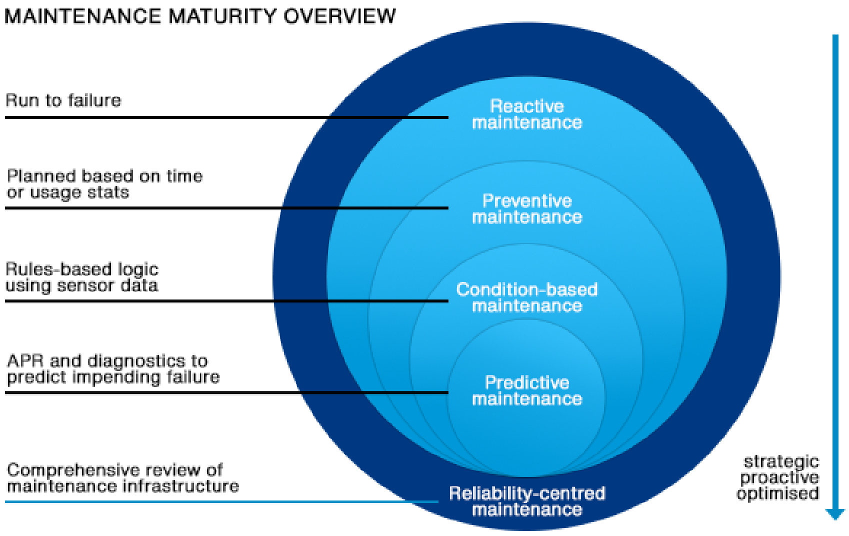
A distinctive feature of TPM is its impact on employee empowerment. By instilling a real sense of ownership among operators and maintainers, TPM encourages a favorable attitude. The deployment of new concepts across the organization facilitates knowledge sharing and experience exchange, contributing to continuous improvement.

In conclusion, the comprehensive benefits derived from Total Productive Maintenance extend beyond machinery reliability. TPM's holistic approach influences productivity, costs, customer satisfaction, safety, and employee morale, making it a strategic cornerstone for organizations committed to operational excellence. (Ramesh Gulati,2011)

### Reliability Centered Maintenance (RCM)

Reliability-Centered Maintenance (RCM) stands as a pivotal process within asset management, ensuring the execution of maintenance tasks in an efficient, cost-effective, reliable, and safe manner. These maintenance tasks encompass preventive, predictive, and non-destructive inspection activities aimed at identifying or monitoring flaws within the system, equipment, or component.

RCM, as a component of a holistic cradle-to-grave asset integrity management program, plays a vital role. An effective RCM program is characterized by its ability to comprehensively document the entire process throughout the life cycle of each asset within the facility. The core objective of RCM is to center maintenance and inspection tasks on the enhancement of equipment reliability and safety."



*Picture 2 Maintenance Maturity Overview (Verbus Engineering B.V.,2023)*

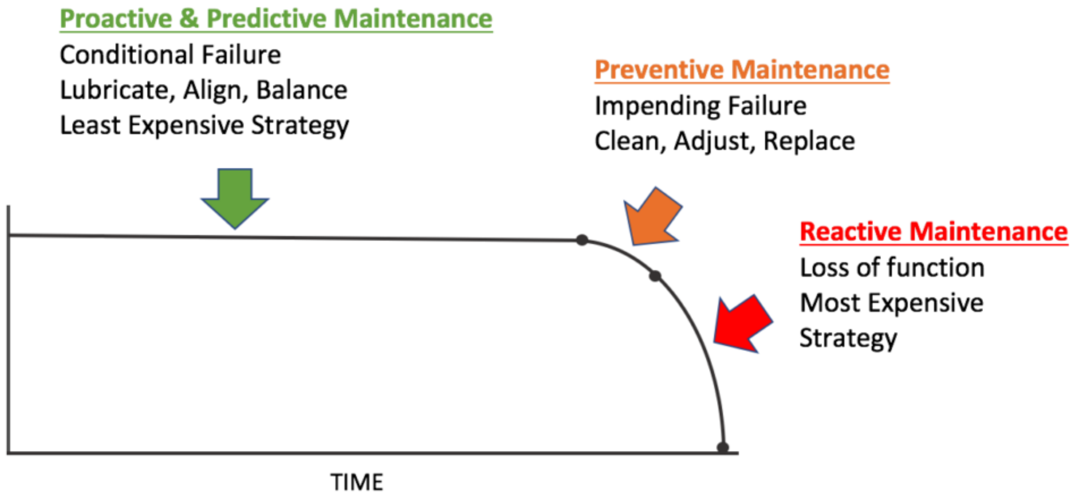
## 2.4 Reliability and Equipment Maintenance

In the realm of industry and technology, the concept of reliability stands as an unwavering pillar, a cornerstone upon which the foundations of operational excellence are built. The reliability of equipment, machinery, and systems is inextricably linked to their efficiency, longevity, and the seamless continuity of operations. It is within the domain of equipment maintenance that this reliability is not only nurtured but meticulously cultivated. This introduction serves as a prelude to a comprehensive exploration of reliability and equipment maintenance, emphasizing their pivotal roles in ensuring the dependability and functionality of industrial assets.

### 2.4.1 The Essence of Reliability

Reliability, in its most fundamental form, is the assurance that systems and equipment will perform their intended functions with consistency, accuracy, and without unexpected interruptions. It is the bedrock upon which manufacturing, transportation, energy production, and countless other industries rely to fulfill their missions. In essence, reliability is a sacred covenant between man and machine, promising uninterrupted performance in an increasingly complex and interconnected world.

Reliability finds its heart in equipment maintenance, an amalgamation of practices and strategies that safeguard the integrity and functionality of industrial assets. As industries evolve and technology advances, the management of equipment maintenance has evolved from a reactive necessity to a proactive and systematic discipline.



*Picture 3 Maintenance Strategies Types (Jean Essam September 28, 2019)*

The main purpose of regular maintenance is to ensure that all equipment required for production is operating at 100% efficiency at all times

“People cannot be more productive than the system they work in allows them to be" (Jean Essam, September 28, 2019)

## 2.5 Maintenance Optimization Strategies

In an ever-evolving industrial landscape where the efficiency, longevity, and cost-effectiveness of equipment and systems are paramount, maintenance optimization strategies have emerged as a critical pathway to achieving operational excellence. These strategies are the lighthouse guiding organizations through the turbulent seas of breakdowns, downtime, and inefficiencies. This introduction lays the groundwork for a comprehensive exploration of maintenance optimization strategies, emphasizing their significance and profound influence on the performance, resilience, and competitiveness of industries.

### 2.5.1 The Essence of Maintenance Optimization

Maintenance optimization is a systematic and purposeful approach to achieving the most effective and efficient use of resources, time, and capital in the maintenance of assets, machinery, and systems. It is rooted in the fundamental principle of doing the right maintenance at the right time. This encompasses a spectrum of activities, from preventive and predictive maintenance to condition monitoring and the establishment of a culture of continuous improvement.

Maintenance optimization strategies are the gatekeepers of reliability and asset health. They serve as the linchpin that balances the costs and risks of maintenance with the benefits of extended equipment life and uninterrupted operations. These strategies encompass methodologies, tools, and best practices that holistically address maintenance processes.

### 2.3.2. The Imperative of Maintenance Optimization

In the context of industrial operations, maintenance optimization is not a luxury but an imperative. Industries face a myriad of challenges that demand efficient and cost-effective asset management. These challenges include:

**Equipment Complexity**: The modern industrial landscape is replete with intricate machinery, each with unique maintenance requirements.

**Resource Allocation**: The allocation of human and financial resources for maintenance is a constant puzzle.

**Downtime Costs:** Production disruptions are not just financial; they can erode competitiveness, damage reputation, and risk safety.

**Environmental and Safety Regulations:** Industries must comply with an ever-increasing array of environmental and safety standards.

#### The Evolving Landscape of Maintenance Optimization

In recent years, maintenance optimization strategies have evolved significantly. Traditionally, industries employed reactive maintenance approaches, addressing issues as they occurred. However, modern industries are embracing predictive maintenance with sensors, data analytics, and machine learning. Predictive maintenance is the cornerstone of maintenance optimization, enabling industries to forecast equipment failures and prevent disruptions.

The application of reliability-centered maintenance (RCM) principles has gained prominence, guiding industries to identify critical assets, assess their risk profiles, and tailor maintenance strategies accordingly. In this digital age, the integration of data and technology has given birth to an era where equipment and machinery communicate their health, providing insights for predictive and condition-based maintenance.

## 2.6 Lean Maintenance in Brewing

In the dynamic world of brewing, where art and science unite to craft the perfect brew, efficiency, and reliability are paramount. Brewing is an intricate process that combines tradition and innovation, and within this blend, the principles of lean maintenance have found fertile ground. This introduction serves as the gateway to a comprehensive exploration of lean maintenance in brewing, emphasizing its importance and profound impact on the brewing industry's quest for operational excellence.

## 2.7 Beer Production and Brewery Operations

In the world of beverages, few are as iconic and beloved as beer, and behind every pint of this frothy elixir lies a complex tapestry of production and operational processes. This introduction sets the stage for a comprehensive exploration of beer production and brewery operations, emphasizing their significance and the intricate dance that occurs behind the scenes to bring this cherished drink to life.

### 2.7.1 The Magic of Beer Production

Beer production is a fusion of artistry, science, and engineering. At its core, it's the transformation of simple ingredients—water, malt, hops, and yeast—into a beverage of infinite variety and nuance. However, this transformation is not a simple one. It requires the orchestration of complex machinery, precise processes, and a deep understanding of fermentation, all while adhering to stringent quality and safety standards.

Beer production is more than the sum of its parts; it's a cultural and industrial phenomenon. The history and traditions of brewing stretch back centuries, interwoven with regional flavors, craftsmanship, and an evolving palate. Today, the craft of brewing is not limited to the artisanal brewer in a remote village; it's an industrial process that produces billions of gallons annually.

### 2.7.2 The Unseen World of Brewery Operations

While the consumer may savor a beer's aroma, flavor, and mouth feel, the success of any brewery hinges on what occurs behind the scenes—brewery operations. These operations encompass the full scope of activities required to bring a brew to market, from ingredient procurement and recipe formulation to brewing, fermentation, packaging, and quality control.

Brewery operations extend further into supply chain management, distribution, marketing, and compliance with stringent regulations governing the production and sale of alcoholic beverages. Behind the brewery's inviting taproom or the labels on your favorite six-pack, there's an intricate web of processes, logistics, and quality assurance measures that ensure consistent product quality and market availability.Article: "Production and operations management in the craft brewing industry" by C. R. Irani, A. K. K. Kapoor, and C. A. Kumbaroglu in the International Journal of Production Research.

# Chapter 3

# Brewery Industry Overview

## 3.1 Brewery Industry Overview

The brewery industry, a cornerstone of the global beverage market, is characterized by its rich diversity and dynamic nature. At its core, this industry revolves around the production of beer, a universally consumed beverage with a vast and varied consumer base. Breweries span a wide spectrum, ranging from small craft establishments that pride themselves on artisanal creations to large-scale industrial breweries churning out mass quantities of the beloved brew. A typical brewery comprises a complex ecosystem of components, each playing a crucial role in the intricate beer production process.

In the heart of a brewery lies the malt silo, serving as a strategic storage facility for malted barley—the fundamental ingredient in brewing. The mill, a pivotal component, finely grinds the malt into the precise consistency required for the subsequent stages. The mash tank then comes into play, initiating a chemical reaction with hot water to create the wort, a sugary liquid foundational to beer production. From fermentation tanks (CCTs) where yeast works its magic to bright beer tanks (BBTs) for conditioning and clarification, the journey is a meticulous orchestration of processes.

Various technologies and techniques are employed in breweries worldwide, with distinct methodologies often defining the character of the final product. Craft breweries, known for their innovation and emphasis on unique flavors, may employ traditional brewing methods, while large-scale industrial breweries leverage advanced automation and quality control systems for efficiency and consistency. The choice of equipment, from the type of fermentation vessels to the approach in wort boiling, contributes to the diversity of beers available in the market.

Comparisons within breweries often revolve around the selection of technology, scale of production, and the level of craftsmanship. Craft breweries, often celebrated for their experimentation and attention to detail, may prioritize manual or semi-automated processes, leading to smaller batches with distinct characteristics. Industrial breweries, on the other hand, focus on economies of scale, implementing sophisticated machinery and automated systems to handle large volumes efficiently.

The critical areas within a brewery, including the cleanliness and hygiene maintained through CIP stations, the precision in temperature control via cooling and refrigeration systems, and the environmental sustainability achieved through CO2 recovery and wastewater treatment systems, collectively contribute to the overall efficiency and quality of the brewing process.

In conclusion, the brewery industry, with its diverse players and array of technologies, encapsulates a blend of tradition, innovation, and craftsmanship. As the brewing landscape continues to evolve, the careful balance between the art and science of brewing remains pivotal, with each brewery contributing its unique flavor to the ever-expanding world of beer.

*Picture 4 The Chemistry of Beer (Andy Brunning ,2014)*

**Malt Silo**: The malt silo is a crucial component in the intricate dance of brewing, serving as a strategic storage facility that holds the essence of beer production—malted barley. As a cornerstone ingredient, malted barley contributes essential sugars and flavors to the brewing process. Beyond its symbolic importance, the malt silo plays a practical role, offering a structured and efficient solution for the handling and management of the barley supply. This vertical storage unit ensures that the malted barley remains in optimal condition, shielded from external elements that could compromise its quality. The malt silo's design facilitates streamlined access, allowing brewers to retrieve precise quantities of malt with ease, promoting consistency in the brewing recipes. In essence, the malt silo is not merely a vessel; it is a strategic hub that safeguards the integrity of the brewing process, embodying the synergy of tradition and modern efficiency in the art of brewing.

*Picture 5 Malt Silo (Greek Vergina Brewery, 2022)*

**Mill**: The mill stands as a pivotal artisan in the symphony of brewing, its role crucial in transforming raw potential into the essence of fermentation. Charged with the responsibility of crushing malted barley, this mechanical maestro ensures that the grains achieve the precise consistency necessary for unlocking their hidden treasures. The mill's rhythmic precision is paramount, releasing not only the essential sugars but also the starches inherent in malted barley. In this transformative act, the mill becomes the herald of the brewing process, setting the stage for the alchemical dance between yeast and sugars that will unfold in subsequent stages. The finely tuned collaboration between the mill and malted barley epitomizes the craftsmanship of brewing, where the mechanical and the organic harmonize to initiate the journey from grain to golden nectar.

*Picture 6 Mill system (GEA, 2023)*

**Mash Tank**: The mash tank serves as the alchemical crucible in the beer production process, where the milled malt undergoes a transformative dance with hot water, giving rise to the foundational elixir known as wort. In this vessel of brewing enchantment, the meticulously milled malt, having undergone the precision of the mill, encounters hot water in a carefully choreographed ritual. The union initiates a complex chemical reaction, a conversion of starches within the malt into fermentable sugars. This alchemy unfolds under carefully controlled temperature and time parameters, orchestrated by the brewer's expertise. The result is the creation of wort—a sugary liquid imbued with the essence of the malt. The mash tank, thus, emerges as a sacred space where the artistry of the brewer, the science of temperature, and the magic of malt converge, setting the stage for the subsequent acts of fermentation and the ultimate manifestation of beer.

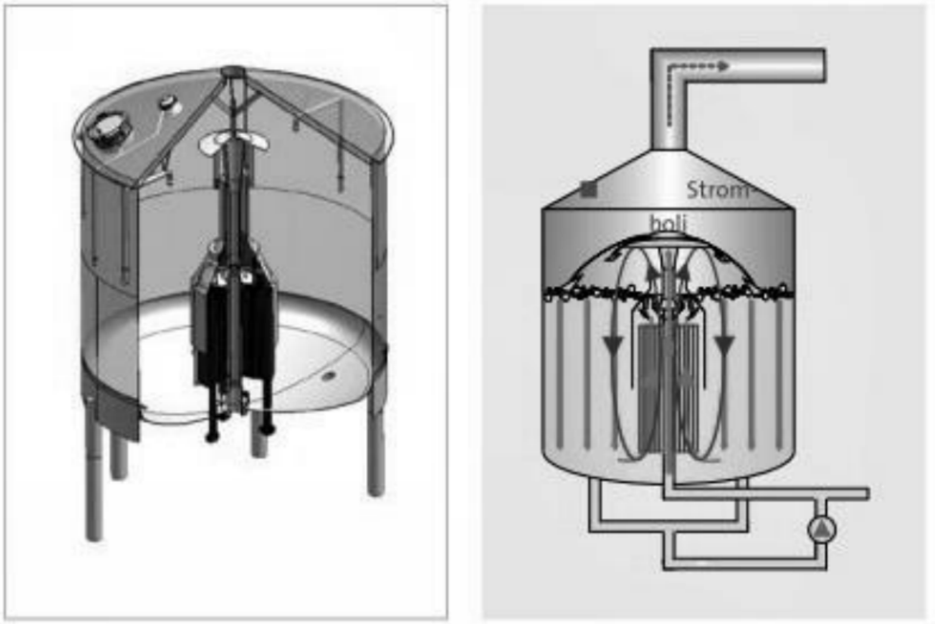
Picture 7 Mash Tun (TM INOX)

**Lauter tank:** The lauter tank in a brewery is a crucial vessel designed for the separation of solid remnants, such as spent grain, from the liquid wort after the mashing process. Acting as a refining stage in the beer production journey, the lauter tank facilitates the extraction of the sugary liquid from the mash while efficiently filtering out residual solids. Its perforated floor allows the wort to flow through while retaining the spent grain, a process often referred to as lautering. This meticulous separation not only ensures the clarity and purity of the wort but also contributes to the efficiency and consistency of subsequent brewing stages. The lauter tank, therefore, stands as an instrumental player in the pursuit of producing high-quality beer, embodying the meticulous craftsmanship that characterizes the art and science of brewing.

Picture 8 Luter Tun (GEA ,2023)

**Holding Vessel**: The holding vessel assumes a pivotal role in the symphony of brewing, acting as a temporal sanctuary for the nascent wort and orchestrating the seamless flow between brewing stages. This vessel, akin to a conductor guiding a musical ensemble, carefully manages the fluid transition of the precious wort. Serving as a strategic reservoir, it allows the brewer to exercise control over the pace of the brewing process, facilitating a harmonious rhythm between stages. The holding vessel's significance lies in its ability to regulate the flow of wort, preventing disruptions and ensuring a continuous progression through the brewing journey. This intermediary haven not only safeguards the integrity of the wort but also provides the brewer with the flexibility to fine-tune and optimize subsequent steps in the alchemical transformation that is beer production.

**Wort Kettle**: The wort kettle, a central stage in the alchemical process of beer brewing, serves as the cauldron where the transformative magic of boiling unfolds. In this crucible, the extracted wort undergoes a crucial thermal baptism, reaching the boiling point to achieve the desired sterilization and chemical reactions. This pivotal stage not only ensures the elimination of potential contaminants but also serves as the canvas for the artistry of flavor infusion. The introduction of hops during this boiling process imparts nuanced flavors and enticing aromas to the wort. The wort kettle thus becomes a stage for the dynamic interplay of heat, hops, and liquid gold, setting the foundation for the distinctive character that each brew will embody. It is in this vessel that the raw potential of the ingredients converges, as the alchemy of brewing continues tounfold,unlocking the sensory symphony that defines a well-crafted beer.



Cross-sectional view

Circulation circuits

*Picture 9 Stromboli internal wort boiling system (Krones, 2013)*

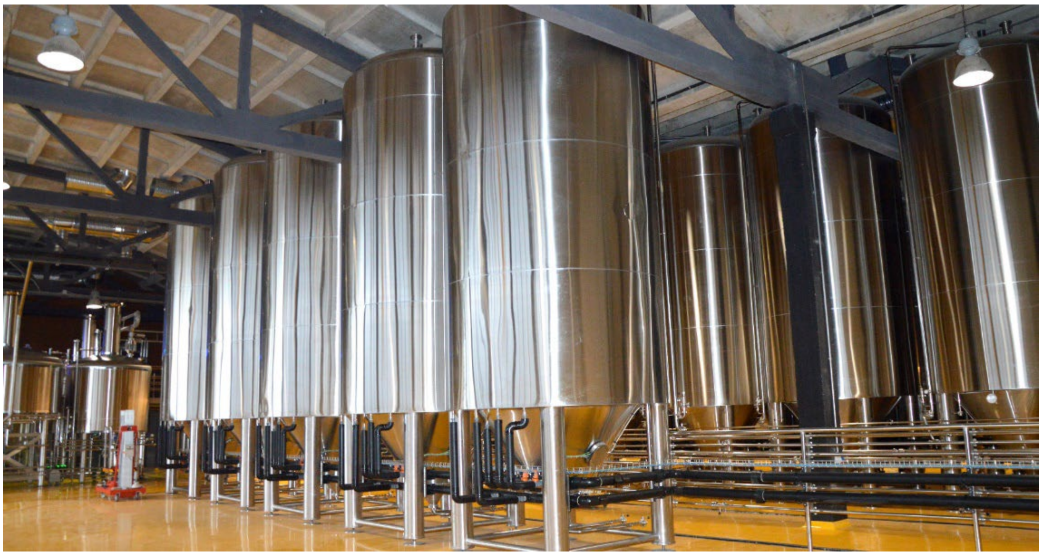
**Whirlpool**: The whirlpool, a key apparatus in the post-boiling stages of beer production, serves as a refining maestro in the journey from brew kettle to fermentation. After the intense heat of the boiling phase, the whirlpool comes into play, creating a swirling vortex within the wort. This dynamic movement encourages solid particles and residual hops to gather in a central cone, segregating them from the liquid wort. The centrifugal force generated in the whirlpool ensures the efficient separation of unwanted particulates, contributing to the overall clarity and purity of the liquid. This meticulous process not only enhances the aesthetic appeal of the beer but also prevents undesirable flavors and aromas, refining the essence of the brew. The whirlpool, in its elegant simplicity, stands as a testament to the meticulous craftsmanship inherent in the pursuit of brewing excellence.

**Hot and Cold Water Tanks**: The hot and cold water tanks in a brewery stand as thermal architects, orchestrating the delicate ballet of temperature control essential to the brewing process. Functioning as indispensable components in the brewery's infrastructure, these tanks play a pivotal role in modulating the temperature of water at different stages, ensuring precision and consistency. The hot water tank, acting as a thermal reservoir, provides the elevated temperatures required for crucial processes like mashing. In contrast, the cold water tank serves as a refreshing counterpart, offering a controlled source of chilled water essential for cooling various components post-boiling. Together, these tanks form a dynamic duo, harmonizing the thermal landscape of the brewery and empowering brewers with the ability to fine-tune each stage of the brewing process. Their reliability and adaptability contribute to the overall efficiency and quality of the beer production journey.

**Yeast Tanks**: Yeast tanks emerge as sanctuaries of microbial alchemy within the brewery, devoted to the meticulous cultivation and propagation of the tiny yet transformative yeast organisms. These specialized tanks play an indispensable role in the brewing process, where yeast, the unsung hero, undertakes the magical conversion of sugars into alcohol and flavorful byproducts. Ensuring a reliable and consistent fermentation process, yeast tanks provide an environment optimized for yeast growth and activity. Temperature, nutrient levels, and oxygenation are carefully regulated within these vessels to foster the healthy reproduction of yeast cells. By cultivating a robust yeast population, brewers can achieve the desired fermentation outcomes, ensuring the production of beer with the distinctive flavors and alcohol content characteristic of the brewer's intent. In the realm of beer creation, yeast tanks stand as silent architects, crafting the very essence of the brewer's artistry.

*Picture 10 Yeast Propagation and storage tanks*

**Fermentation Tanks (CCT's)**: Fermentation tanks, often referred to as CCTs (Cylindrical Conical Tanks), stand as the heart of the brewing process, where the transformative alchemy of beer creation unfolds. In these vessels, the enchanting interplay between yeast and sugars takes center stage. As yeast fervently consumes the sugars extracted from malted barley, a profound metamorphosis occurs, culminating in the alchemical conversion of these sugars into alcohol. This pivotal fermentation process not only bestows beer with its intoxicating potency but also imparts the nuanced and distinctive flavors and aromas that define each brew. The controlled environment within the conical tanks allows for the precise regulation of temperature and other variables, enabling brewers to orchestrate a symphony of biochemical reactions. It is within these fermentation tanks that the soul of the beer is crafted, encapsulating the essence of the brewer's artistry and the yeast's transformative power.



*Picture 11 Fermentation Tanks (Ziptech)*

**Separator centrifuge:** The disc stack separator, a pivotal component of the centrifuge brewing system, revolutionizes the separation of solids and liquids in the brewing process through a continuous and efficient mechanism. This specialized centrifuge employs a series of rotating discs to generate high centrifugal forces, facilitating the rapid separation of solid particles, such as yeast and trub, from the liquid phase, which predominantly consists of clarified beer. The disc stack separator's design allows for precise control over the separation process, ensuring the retention of desired beer components while effectively removing unwanted solids. This innovation not only streamlines the brewing workflow but also contributes to the production of clearer and higher-quality beer. The centrifuge brewing system, with its disc stack separator, exemplifies the marriage of advanced technology and brewing artistry, elevating the efficiency and precision of the brewing industry.

*Picture 12 Separator (GEA, 2023)*

**BMF (Beer Membrane Filtration System)**

Beer membrane filtration (BMF) serves a pivotal role in the brewing process, aiming to enhance the clarity and microbiological stability of the final beer product. By effectively eliminating yeast and colloidal particles responsible for haze, BMF contributes to the visual appeal of the beer, ensuring a clear and brilliant appearance. Moreover, the filtration process plays a critical role in maintaining microbiological stability by removing potential pathogens and spoilage microorganisms. This not only safeguards the beer against contamination but also extends its shelf life, guaranteeing a consistent and high-quality product for consumers. In essence, BMF is a key step in the brewing journey, aligning with industry standards to deliver beers that are both visually appealing and microbiologically secure.

*Picture 13 Beer Membrane Filtration System (Pentair, 2023)*

**Bright Beer Tanks (BBT's)**: Bright Beer Tanks (BBTs) emerge as the final artisans in the journey of beer refinement, where the fermented liquid undergoes a transformative metamorphosis. Following the enchantment of fermentation, beer finds its way into these specialized vessels for a phase of meticulous conditioning, clarification, and carbonation. Within the controlled confines of the bright beer tank, residual yeast and particulates settle, contributing to the beer's clarity and brilliance. This stage allows the beer to mature, fostering the development of nuanced flavors and ensuring consistency in taste. Additionally, carbonation is carefully introduced, imparting the effervescence that enhances the beer-drinking experience. Bright beer tanks not only serve as vessels of transformation but also as guardians of quality, shaping the final taste and appearance of the brew before it embarks on its journey to captivate palates and delight discerning beer enthusiasts.

*Picture 14 Bright Beer Tanks*

**CIP (Clean-In-Place) Stations**: Clean-In-Place (CIP) stations stand as vigilant custodians of cleanliness and hygiene within the brewery, ensuring that the equipment involved in the beer production process remains free from contaminants. These stations play an indispensable role in maintaining the quality and safety of the final product by automating the cleaning process without the need for equipment disassembly. CIP systems utilize a series of controlled cycles involving cleaning solutions and sanitizing agents to eliminate residues, microorganisms, and any potential sources of contamination. By incorporating these stations into the brewery's infrastructure, brewers can uphold rigorous hygiene standards, mitigate the risk of off-flavors, and safeguard the integrity of the beer. CIP stations, with their systematic and efficient cleaning protocols, underscore the commitment to producing not only flavorful but also safe and pristine beer, elevating the brewery's reputation and ensuring consumer satisfaction.

Picture 15 Clean in Place Systems (CIP Systems)

**Packaging Equipment**: Packaging equipment serves as the ultimate choreographer in the grand finale of the beer production chain, orchestrating the seamless transition from brewery to consumer. This machinery, encompassing bottle fillers, canning lines, and kegging systems, plays a pivotal role in ensuring that the crafted beer is meticulously packaged and primed for distribution and consumption. Through a meticulously calibrated dance of precision, these systems fill containers with the perfected liquid, applying the final touch to the brewer's masterpiece. Packaging equipment not only encapsulates the brewer's dedication to quality but also extends the longevity of the beer by safeguarding it against external elements. As the last step in the brewing symphony, this machinery embodies the bridge between craftsmanship and consumer delight, presenting the culmination of the brewer's artistry in a form ready to be savored and shared.

Picture 16 Packaging line

**Cooling and Refrigeration Systems:** Cooling and refrigeration systems stand as the unsung heroes in the realm of brewing, performing a vital role in maintaining the delicate dance of temperatures throughout the entire beer production process. From mashing to fermentation and beyond, these systems play a central role in preserving the quality and integrity of the beer. By efficiently regulating and stabilizing temperatures, these systems contribute to the precise control required for various stages, ensuring optimal enzymatic activity during mashing, yeast propagation in fermentation tanks, and the conditioning of the final product in bright beer tanks. The cooling and refrigeration systems not only safeguard the flavor profiles crafted by the brewer but also play a crucial role in preventing undesired off-flavors and ensuring the consistency of the beer. In essence, these systems are the custodians of the brewer's vision, maintaining the cool composure necessary for the alchemy of beer production to unfold with perfection.

*Picture 17 NH3 Compressors (GEA refrigeration solutions, 2020)*

**CO2 recovery system :** The CO2 recovery system and storage facility in a brewery represent an innovative and sustainable approach to managing carbon dioxide, a byproduct of the fermentation process. This system is designed to capture and reclaim the CO2 emitted during fermentation, preventing its release into the atmosphere. The recovered CO2 is then efficiently stored for later use, such as carbonating beer or other operational needs within the brewery. Beyond its ecological benefits, the CO2 recovery system also contributes to cost efficiency by reducing the reliance on external sources for this crucial element in the brewing process. By adopting such environmentally conscious practices, breweries demonstrate a commitment to sustainability, resource optimization, and the reduction of their overall carbon footprint, aligning the brewing industry with the principles of responsible production.

*Picture 18 CO2 Recovery System (GEA, 2023)*

**Compressed air (oil free) and air dryer system:** The compressed air (oil-free) and air dryer system in a brewery serve as the silent workhorses, providing a critical utility that underpins various operations. An oil-free compressed air system is paramount in maintaining the purity and integrity of the final product, ensuring that air, used in various brewery processes, remains free from contaminants that could compromise the quality of the beer. Paired with an air dryer system, this technology efficiently removes moisture from the compressed air, preventing the risk of corrosion in equipment and safeguarding the overall efficiency of brewery operations. This combination not only enhances the longevity of machinery but also aligns with the stringent quality standards essential for the production of consistently high-quality beer. As an essential component of the brewery's infrastructure, the compressed air and air dryer system contribute to the seamless and reliable functioning of the diverse equipment involved in the beer production journey.

*Picture 19 Oil free - Air Compressor and air Dryer (Atlas Copco, 2023)*

**Steam Boiler plan:** The steam boiler plant in a brewery acts as the pulsating heart of the operation, providing the energy essential for various heating processes throughout the brewing journey. Steam boilers generate the high-temperature steam required for tasks ranging from mashing and boiling to cleaning and sterilizing equipment. This versatile and efficient source of energy is a linchpin in maintaining precise temperatures critical to the brewing process. The steam produced by the boiler not only facilitates the extraction of sugars during mashing but also contributes to the vital boiling phase, where hops are introduced to infuse flavor and aroma into the beer. Additionally, the steam boiler plays a pivotal role in the sanitation of equipment through Clean-In-Place (CIP) processes, ensuring the hygiene and safety of the final product. In essence, the steam boiler plant in a brewery symbolizes the nexus of energy, precision, and reliability, powering the diverse stages that transform raw ingredients into the liquid artistry that is beer.

*Picture 20 Steam Boiler (Bosch, 2023)*

**Water Treatment plant (reverse osmosis) and water storage tanks:** The water treatment plant, featuring reverse osmosis technology, coupled with water storage tanks, represents a critical juncture in a brewery's commitment to water quality and consistency. This advanced water treatment system employs reverse osmosis to meticulously purify water by removing impurities, minerals, and contaminants, ensuring that the brewery starts with a pristine foundation for brewing. The treated water is then efficiently stored in dedicated tanks, providing a consistent and controlled water supply for various brewing processes. Beyond enhancing the flavor profile of the beer, this system contributes to the longevity of brewing equipment by minimizing the risk of scaling and corrosion. The integration of a water treatment plant and storage tanks not only reflects a dedication to brewing excellence but also aligns with sustainable practices by optimizing water usage and maintaining a high standard of water quality throughout the brewing journey.

*Picture 21 Reverse Osmosis (FPX Solutions, 2023)*

**Waste water treatment plan:** The wastewater treatment plan, incorporating both anaerobic and aerobic treatment processes, stands as a testament to a brewery's commitment to environmental responsibility and sustainability. In the anaerobic treatment phase, organic pollutants in the brewery's wastewater are broken down by microorganisms in the absence of oxygen, producing biogas as a byproduct. This biogas can be repurposed as an energy source, contributing to the brewery's overall eco-efficiency. Subsequently, in the aerobic treatment stage, the wastewater undergoes further purification in the presence of oxygen, reducing the concentration of remaining pollutants. The culmination of both anaerobic and aerobic treatments ensures a comprehensive and environmentally conscious approach to managing brewery wastewater, mitigating its impact on local ecosystems and adhering to stringent environmental regulations. By adopting such dual-treatment methods, breweries not only fulfill their ecological responsibilities but also demonstrate a proactive stance in reducing their environmental footprint.

*Picture 22 Waste Water Treatment Plan (Hydrotech,2001)*

In the ever-evolving landscape of the brewery industry, technological advancements have propelled brewing processes into a realm of unprecedented automation. From mills and lauter tanks to steam boilers and cooling systems, the integration of high-tech solutions has streamlined operations, increased efficiency, and elevated the overall quality of beer production. Despite the march toward automation, the industry grapples with the need for meticulous equipment maintenance. While modern breweries may require fewer operators due to increased automation, the criticality of maintaining this sophisticated machinery has never been higher. A well-structured maintenance plan becomes paramount in this scenario, where planning and scheduling are the linchpins for the smooth operation and protection of these valuable assets. In the realm of maintenance, two key approaches emerge: corrective maintenance, aimed at restoring equipment to proper working order following detection of anomalies, and reactive maintenance, carried out after the identification of faults. Striking a balance between cutting-edge technology and a robust maintenance strategy is essential for ensuring the sustained success of breweries in this era of brewing innovation.

# Chapter 4

# Optimizing Preventive Maintenance in a Cyprus Brewery

## 4.1 Introduction

Maintenance is a critical aspect of ensuring the smooth and efficient operation of industrial processes, particularly in complex industries such as brewing. The core objective of this thesis has been to delve into the realm of maintenance processes within a brewery context, with a specific focus on preventive maintenance. As outlined in the earlier chapters, the brewing industry demands meticulous attention to equipment reliability and operational continuity.

In the initial stages of this research, the overarching goal was to understand the existing preventive maintenance practices in a selected brewery located in Cyprus. Through a comprehensive analysis, we identified specific issues and challenges that impeded the optimal functioning of preventive maintenance protocols. These challenges ranged from inadequate monitoring systems to the absence of a streamlined method for consolidating existing plans of interest.

Building upon these observations, the primary aim of this thesis is to propose practical solutions for enhancing preventive maintenance in the brewery. As we transition into the practical application phase, the focus narrows down to the selected brewery in Cyprus, where the theoretical frameworks and identified opportunities will be put to the test.

This chapter serves as the bridge between theory and application, outlining the opportunities for improvement, conducting a SWOT analysis, and introducing a proposed Excel tool that aims to revolutionize the brewery's preventive maintenance processes. By the conclusion of this practical application, we anticipate not only addressing the challenges faced by the selected brewery but also contributing valuable insights to the broader field of maintenance optimization in the brewing industry. The journey from theory to application is now set to unfold, with the ultimate goal of fostering a more resilient and efficient maintenance strategy in the context of beer production.

## 4.2. Review of Preventive Maintenance Issues

*Overview of Current Preventive Maintenance Practices:*

Within the brewery under examination in Cyprus, the prevailing approach to maintenance is primarily reactive, characterized by a reliance on the experience and expertise of seasoned mechanics. Notably absent is a well-defined preventive maintenance plan, leading to a reactive firefighting strategy that addresses breakdowns as they arise. Distinct plans exist for various equipment categories, ranging from cooling systems and silo boilers to reverse osmosis, wastewater treatment, air compressors, CO2 recovery, and an array of machinery associated with the brew house, including motors, pumps, gearboxes, valves, among others. Unfortunately, these plans lack a cohesive structure, heavily relying on the institutional knowledge held by a select group of experienced mechanics.

*Identified Issues and Challenges:*

The challenges stemming from the existing maintenance strategy are multifaceted. The absence of a centralized and standardized preventive maintenance plan leads to a fragmented approach, resulting in isolated responses to maintenance issues. This fragmentation increases the likelihood of critical components being inconsistently addressed, contributing to the heightened risk of unforeseen breakdowns. Furthermore, the reliance on the expertise of a limited number of experienced mechanics introduces a potential knowledge transfer gap, where critical insights may not be adequately documented or passed on to the broader maintenance team.

*Implications on Operational Efficiency and Downtime:*

The ramifications of the current maintenance strategy extend deep into operational efficiency and downtime. The brewery functions akin to "firefighters," responding reactively to breakdowns rather than proactively preventing them. This reactive stance contributes to operational inefficiencies, as resources are predominantly allocated in response to urgent maintenance needs. The lack of a systematic preventive maintenance approach amplifies downtime due to unexpected failures. Additionally, the absence of a structured method for predicting resource requirements makes effective planning and budgeting challenging, as the brewery grapples with the unpredictability of maintenance needs.

*Discussion:*

In light of these challenges, a fundamental shift in maintenance strategy becomes imperative. The brewery must transition from a reactive to a proactive approach, necessitating the development of comprehensive preventive maintenance plans. These plans should be grounded in equipment manuals, industry best practices, and a systematic understanding of critical components. The proposed Excel tool, a key focus of this thesis, emerges as a transformative solution to automate and streamline this transition. By embedding preventive maintenance into the regular operational framework, the brewery can systematically plan and execute maintenance activities, minimizing downtime and optimizing resource allocation.

In the subsequent sections of this chapter, we will delve into the specific opportunities for improvement, conduct a SWOT analysis, and expound upon the functionalities and benefits of the proposed Excel tool. This comprehensive approach aims not only to address the identified challenges within the brewery but also to contribute valuable insights to the broader field of maintenance optimization within the brewing industry.

## 4.3. Opportunities for Improvement

*Exploring Potential Opportunities for Improving Preventive Maintenance:*

Amidst the current challenges in the brewery's maintenance practices, several promising opportunities for improvement emerge. These opportunities not only address the existing gaps but also lay the foundation for a robust preventive maintenance framework.

Firstly, a pivotal opportunity lies in the consolidation and standardization of maintenance plans across diverse equipment categories. By unifying these plans into a cohesive structure, the brewery can establish a systematic approach to preventive maintenance. This involves categorizing critical components, understanding their maintenance requirements based on manuals, and developing comprehensive schedules.

Secondly, the introduction of a predictive maintenance strategy, facilitated by the proposed Excel tool, offers a significant advancement. Leveraging historical maintenance data, the brewery can move beyond reactive responses and proactively predict when equipment is likely to require attention. This shift towards predictive maintenance allows for more efficient resource allocation, reducing downtime and enhancing overall operational efficiency.

Additionally, the implementation of condition-based monitoring systems presents another opportunity. By utilizing sensors and data analytics, the brewery can monitor the real-time health of critical equipment. This data-driven approach enables timely interventions, preventing unexpected failures and extending the lifespan of machinery.

*Benefits of Addressing Opportunities:*

Addressing these opportunities translates into tangible benefits for the brewery, fundamentally transforming its maintenance landscape.

### 4.3.1. Increased Equipment Reliability:

Standardizing preventive maintenance plans ensures that critical components across various equipment categories receive consistent attention. This, in turn, enhances the reliability of machinery, reducing the likelihood of unexpected breakdowns.

### 4.3.2. Proactive Downtime Reduction:

The shift from reactive to predictive maintenance means that potential issues can be identified and resolved before they escalate. This proactive approach minimizes downtime, allowing the brewery to operate more smoothly and efficiently.

### 4.3.3. Resource Optimization:

Implementing a condition-based monitoring system and an automated Excel tool facilitates optimal resource allocation. With insights into when maintenance is required, the brewery can schedule manpower, order necessary parts, and allocate time efficiently, reducing unnecessary costs associated with emergency responses.

### 4.3.4. Improved Planning and Budgeting:

The establishment of standardized preventive maintenance plans, coupled with predictive strategies, contributes to better planning and budgeting. The brewery gains foresight into maintenance needs, enabling more accurate budget projections and resource allocation for the upcoming periods.

In essence, embracing these opportunities is not merely a refinement of the existing maintenance approach but a transformative journey towards a proactive, efficient, and cost-effective preventive maintenance strategy. The subsequent section will delve into a SWOT analysis, evaluating the internal strengths and weaknesses, along with the external opportunities and threats, to further guide the brewery's path toward optimization.

## 4.4. SWOT Analysis: Preventive Maintenance Practices in the Brewery

In this section, we conduct a SWOT analysis to assess the current state of preventive maintenance practices within the brewery. By identifying strengths, weaknesses, opportunities, and threats, we gain a comprehensive understanding of the internal and external factors influencing the proposed changes. This analysis serves as a crucial groundwork for the subsequent exploration of the Excel tool, shedding light on how it can strategically capitalize on strengths, mitigate weaknesses, leverage opportunities, and address potential threats in the brewery's maintenance approach.

**Strengths:**

1. **Experienced Workforce:**

   The brewery benefits from an experienced team of mechanics, whose wealth of institutional knowledge and practical expertise serves as a foundational strength in addressing complex maintenance issues.

2. **Established Equipment History:**

   Over the years, the brewery has accumulated a wealth of historical maintenance data, providing valuable insights into equipment performance and common issues.

3. **Diverse Equipment Categories:**

   The brewery's diverse range of equipment categories offers an opportunity for comprehensive preventive maintenance planning, covering cooling systems, silo boilers, reverse osmosis, and more.

**Weaknesses:**

1. **Reactive Maintenance Culture:**

   A prevalent reactive maintenance culture poses a challenge in establishing proactive preventive maintenance plans, leading to unpredictable downtimes and potential disruptions in the production process.

2. **Overreliance on Experienced Personnel:**

   The dependency on a few experienced mechanics introduces a knowledge gap and the risk of insufficient documentation, hindering the effective transfer of critical insights to the broader maintenance team.

3. **Lack of Standardized Plans:**

   The absence of standardized preventive maintenance plans results in inconsistent approaches to critical components, contributing to increased breakdown risks and operational uncertainties.

**Opportunities:**

1. **Consolidation and Standardization:**

   The opportunity to consolidate and standardize maintenance plans stands as a significant chance to create a cohesive framework for preventive maintenance, promoting efficiency and consistency across operations.

2. **Predictive Maintenance Implementation:**

   The proposed Excel tool offers a practical avenue for implementing predictive maintenance strategies, facilitating a shift from reactive to proactive maintenance approaches and enhancing overall operational resilience.

3. **Condition-Based Monitoring:**

   Integration of condition-based monitoring systems presents an opportunity for real-time tracking of equipment health. This enables timely interventions, reducing the likelihood of unexpected breakdowns and optimizing maintenance resources.

**Threats:**

1. **Resistance to Change:**

   There may be resistance among the workforce to embrace new preventive maintenance methodologies, particularly if there is a perceived disruption to existing workflows.

2. **Resource Constraints:**

   Limited resources, both in terms of manpower and budget, may pose a threat to the effective implementation of the proposed changes.

3. **Technological Challenges:**

   The integration of automated systems, such as the Excel tool, may face technological challenges or require additional training for the workforce.

**Impact on Proposed Changes**

**Internal Factors:**

The experienced workforce and established equipment history provide a strong foundation for the proposed changes.

Overreliance on experienced personnel and the lack of standardized plans, however, may impede the smooth transition.

**External Factors:**

Opportunities like consolidation and standardization align well with the brewery's diverse equipment categories.

Threats, such as resistance to change and resource constraints, emphasize the need for effective change management and strategic resource allocation.

In the upcoming section, we will delve into the specifics of the proposed Excel tool, exploring how it can effectively address the identified weaknesses and leverage the strengths and opportunities within the brewery's preventive maintenance practices.

This SWOT analysis sets the stage for a strategic evaluation of the brewery's current preventive maintenance landscape, laying the groundwork for the subsequent development and implementation of targeted optimization strategies.

## 4.5. Reverse SWOT Analysis: Converting Weaknesses and Threats into Strengths and Opportunities

In a proactive approach to enhance preventive maintenance practices within the brewery, a reverse SWOT analysis identifies key strategies to convert weaknesses into strengths and threats into opportunities.

**Converting Weaknesses into Strengths:**

1. **Weakness: Reactive Maintenance Culture**

   *Conversion Strategy:* Implement a comprehensive training program to shift the maintenance culture from reactive to proactive. Leverage the experience of seasoned mechanics to educate the broader team on the benefits of preventive maintenance.

2. **Weakness: Overreliance on Experienced Personnel**

   *Conversion Strategy:* Establish a mentorship program to facilitate knowledge transfer from experienced mechanics to newer team members. Encourage documentation of insights and best practices, creating a repository for shared learning.

3. **Weakness: Lack of Standardized Plans**

   *Conversion Strategy:* Develop a cross-functional team to collaborate on the creation of standardized preventive maintenance plans. Draw on the diverse expertise within the workforce to ensure comprehensive coverage of critical components.

**Converting Threats into Opportunities:**

1. **Threat: Resistance to Change**

   *Conversion Strategy:* Foster a culture of continuous improvement by involving the workforce in the decision-making process. Highlight the benefits of the proposed changes, such as increased efficiency and reduced downtime, to gain buy-in and minimize resistance.

2. **Threat: Resource Constraints**

   *Conversion Strategy:* Prioritize preventive maintenance initiatives based on criticality. Develop a phased implementation plan that aligns with available resources, emphasizing the long-term cost savings and operational benefits of the proposed changes.

3. **Threat: Technological Challenges**

   *Conversion Strategy:* Provide comprehensive training on the proposed Excel tool and any associated technologies. Create a support system for employees to address any technical challenges, fostering a culture of adaptability and continuous learning.

**Overall Strategy:**

1. **Leverage Experience:**

   Utilize the experience of the existing workforce not only to guide preventive maintenance strategies but also to champion a cultural shift towards proactive maintenance.

2. **Encourage Collaboration:**

   Foster collaboration among team members, encouraging them to contribute to the creation of standardized plans. This collaborative approach ensures a holistic understanding of maintenance needs.

3. **Communication and Education:**

   Communicate the benefits of preventive maintenance clearly to address resistance. Provide ongoing education and training to empower the workforce with the skills needed for the proposed changes.

4. **Strategic Planning:**

   Develop a strategic implementation plan that aligns with available resources and addresses potential technological challenges. Prioritize initiatives based on their impact on operational efficiency and equipment reliability.

This reverse SWOT analysis serves as a strategic guide, providing actionable steps to transform challenges into opportunities and weaknesses into strengths. The ensuing section will delve into the specifics of the proposed Excel tool, illustrating how it aligns with these conversion strategies and contributes to the overall success of the preventive maintenance optimization initiative.

## 4.6. Proposed Excel Tool for Preventive Maintenance Optimization

*Introduction to the Excel Tool:*

In addressing the complex landscape of preventive maintenance within the brewery, the introduction of an Excel-based tool stands as a key pillar in our strategy for optimization. This tool is envisioned as a comprehensive, automated system designed to streamline and enhance the preventive maintenance process. By leveraging the familiar and versatile environment of Microsoft Excel, we aim to bridge the gap between advanced maintenance management systems and practical, user-friendly implementation within the brewery setting.

**Rationale Behind Choosing an Automated System:**

1. **Efficiency and Accuracy:**

   An automated system is essential for achieving efficiency and accuracy in preventive maintenance planning. Automation reduces the manual workload, minimizes the risk of human error, and ensures that maintenance plans are consistently executed, contributing to increased overall operational efficiency.

2. **Centralized Information Hub:**

   The Excel tool acts as a centralized information hub, consolidating data from various equipment categories. This facilitates a holistic view of the preventive maintenance landscape, enabling the creation of standardized plans that comprehensively address critical components across the brewery.

3. **Predictive Maintenance Capabilities:**

   Automation within the Excel tool enables the implementation of predictive maintenance strategies. By analyzing historical maintenance data, the tool can predict when equipment is likely to require attention, allowing for proactive planning and resource allocation.

4. **User-Friendly Interface:**

   Excel provides a user-friendly interface that is familiar to most employees. This minimizes the learning curve and ensures that the tool can be readily adopted by the existing workforce, fostering collaboration and engagement in the preventive maintenance process.

**Why Excel is Suitable for this Purpose:**

1. **Accessibility:**

   Microsoft Excel is a widely accessible and familiar tool in most organizational settings. Its ubiquity ensures that the preventive maintenance tool can be easily integrated into the existing workflow, with minimal disruption to daily operations.

2. **Customization:**

   Excel's flexibility allows for the customization of the tool to suit the specific needs of the brewery. This adaptability is crucial in accommodating the diverse range of equipment categories and maintenance requirements present in the brewing environment.

3. **Low Implementation Cost:**

   Compared to specialized maintenance management software, the implementation cost of an Excel-based tool is considerably lower. This aligns with the brewery's resource constraints, providing a cost-effective solution for preventive maintenance optimization.

4. **Ease of Collaboration:**

   Excel facilitates seamless collaboration among team members. Multiple users can contribute to and access the tool concurrently, fostering a collaborative approach to preventive maintenance planning.

In the subsequent sections, we will delve into the structure and functionalities of the proposed Excel tool, outlining how it will effectively address the identified challenges and contribute to the overall enhancement of preventive maintenance practices within the brewery.

## 4.7. Structure of the Excel Tool for Preventive Maintenance Optimization

*In the pursuit of preventive maintenance optimization within the brewery, the Excel tool is strategically designed with key features and components to revolutionize the maintenance approach. The structure of the tool is carefully crafted to address existing challenges and introduce efficiency-enhancing elements.*

**Key Features and Components:**

1. **Equipment Database:**

   The Excel tool will feature a centralized equipment database that catalogues all machinery and systems within the brewery. This database will include details such as equipment specifications, historical maintenance data, and critical component information.

2. **Standardized Maintenance Plans:**

   To address the current lack of standardized plans, the Excel tool will facilitate the creation and storage of standardized preventive maintenance plans for each equipment category. These plans will outline specific tasks, frequencies, and procedures for maintaining critical components.

3. **Historical Maintenance Data Repository:**

   A repository for historical maintenance data will be integrated, allowing the tool to analyze past incidents and trends. This historical perspective is crucial for the implementation of predictive maintenance strategies, enhancing the tool's ability to forecast future maintenance needs.

4. **Automated Scheduling:**

   The tool will incorporate automated scheduling functionality. Based on equipment specifications and historical data, it will generate preventive maintenance schedules, ensuring that tasks are planned at optimal intervals to prevent unexpected breakdowns and minimize downtime.

5. **Alerts and Notifications:**

   To enhance responsiveness, the Excel tool will feature an alert system. Automated notifications will be generated for upcoming maintenance tasks, ensuring that the maintenance team is proactively informed about pending activities and can allocate resources accordingly.

6. **User-Friendly Interface:**

   The interface will be designed for ease of use, ensuring that both experienced mechanics and new team members can navigate the tool effortlessly. This user-friendly design aims to encourage broad adoption within the workforce.

**Gathering Existing Plans of Interest and Monitoring Activities:**

1. **Data Import Functionality:**

   The Excel tool will have the capability to import existing maintenance data and plans from diverse sources. This ensures a smooth transition from the current fragmented approach to a centralized, comprehensive system.

2. **Integration with Manuals:**

   To build standardized plans based on manuals, the tool will integrate with equipment manuals and guidelines. This feature ensures that maintenance tasks align with manufacturer recommendations and industry best practices.

3. **Real-Time Data Entry:**

   Maintenance activities will be recorded in real-time through the Excel tool. This feature allows for the continuous monitoring of preventive maintenance activities, creating an up-to-date record of each equipment's maintenance history.

4. **Condition Monitoring Integration:**

   For equipment with condition monitoring systems, the tool will integrate with real-time data feeds. This integration allows for the continuous monitoring of equipment health, providing insights into when maintenance interventions are required.

5. **Analytics and Reporting:**

   The Excel tool will incorporate analytics and reporting functionalities. These features enable the generation of comprehensive reports on maintenance activities, equipment reliability, and resource utilization. Such reports facilitate informed decision-making and continuous improvement.

By integrating these features and components, the Excel tool will not only streamline preventive maintenance planning but also foster a data-driven and proactive approach. In the subsequent section, we will discuss the development process of the tool, detailing the steps involved in bringing this comprehensive system to fruition within the brewery.

## 4.8. Development Process of the Automated Preventive Maintenance System

Embarking on the journey to transform preventive maintenance practices, the development process of the automated system unfolds through meticulous steps and considerations. Each stage is strategically designed to address specific needs, integrate historical data, and streamline the scheduling of maintenance tasks. Anticipating challenges and devising mitigation strategies ensures a smooth transition to the enhanced Excel tool.

**Steps Involved in Development:**

1. **Needs Assessment:**

   Conduct a comprehensive needs assessment in collaboration with maintenance personnel to identify specific requirements, functionalities, and desired outcomes for the Excel tool.

2. **Database Design:**

   Develop a structured equipment database that accommodates the diverse range of machinery within the brewery. Include fields for equipment specifications, historical maintenance data, and critical component information.

3. **Standardized Maintenance Plan Creation:**

   Design a user-friendly interface to facilitate the creation and storage of standardized preventive maintenance plans. These plans should be based on equipment manuals, industry best practices, and insights from experienced mechanics.

4. **Historical Data Integration:**

   Develop mechanisms to import and integrate historical maintenance data into the tool. Ensure compatibility with existing data sources to maintain continuity in the analysis of past incidents and trends.

5. **Automated Scheduling Algorithm:**

   Implement an automated scheduling algorithm that generates preventive maintenance schedules based on equipment specifications, historical data, and industry recommendations. Ensure flexibility to accommodate varying frequencies and task complexities.

6. **Alerts and Notifications System:**

   Integrate an alerts and notifications system that sends automated reminders for upcoming preventive maintenance tasks. These alerts should be customizable and accessible to relevant personnel.

7. **User Interface Design:**

   Develop an intuitive user interface that caters to the diverse skill levels within the maintenance team. Prioritize ease of navigation, data entry, and report generation to encourage widespread adoption.

8. **Data Import Functionality:**

   Incorporate data import functionality to facilitate the seamless transition from existing systems. Ensure compatibility with various data sources to aggregate information into the new Excel tool.

9. **Real-Time Data Entry Mechanism:**

   Implement real-time data entry mechanisms for maintenance activities. This may involve mobile interfaces or other methods that allow on-the-spot recording of maintenance interventions.

10. **Condition Monitoring Integration:**

    Develop interfaces for the integration of condition monitoring systems where applicable. This involves establishing connections to real-time data feeds for continuous monitoring of equipment health.

11. **Analytics and Reporting Features:**

    Integrate analytics and reporting features to provide insights into maintenance activities, equipment reliability, and resource utilization. Ensure the generation of clear and actionable reports for decision-making.

**Anticipated Challenges and Mitigation Strategies:**

1. **Resistance to Change:**

   **Mitigation:** Implement a comprehensive change management strategy, including training sessions, workshops, and ongoing communication to address concerns and promote the benefits of the new system.

2. **Data Integration Complexity:**

   **Mitigation:** Develop robust data integration protocols and work closely with IT professionals to ensure seamless migration of historical data from existing systems.

3. **Technological Hurdles:**

   **Mitigation:** Conduct thorough testing during the development phase, including pilot implementations with a small group of maintenance personnel. Provide continuous technical support and training to address any technological challenges.

4. **User Adoption:**

   **Mitigation:** Prioritize user-friendly design and involve maintenance personnel in the development process to ensure that the tool meets their needs and preferences. Provide ongoing support and training to encourage adoption.

5. **Resource Constraints:**

   **Mitigation:** Develop a phased implementation plan that aligns with available resources. Prioritize key functionalities to ensure that critical aspects of preventive maintenance are addressed first.

By following these steps and anticipating potential challenges, the development process of the automated preventive maintenance system can be navigated effectively, ensuring a successful implementation that addresses the unique needs and challenges of the brewery in Cyprus. In the following section, we will discuss the implementation plan, outlining the timeline and strategy for deploying the Excel tool within the brewery.

## 4.9. Implementation Plan for the Excel-Based Preventive Maintenance System

Crafting a meticulous implementation plan is paramount for the successful integration of the Excel-based preventive maintenance system within the brewery. This plan unfolds through distinct phases, addressing key aspects such as needs assessment, database design, user interface development, testing, and rollout. Additionally, a comprehensive training strategy is outlined, ensuring that the existing workforce is equipped with the skills needed for effective tool utilization.

**Timeline and Strategy:**

**Phase 1: Pre-Implementation (Month 1-2)**

1. **Needs Assessment:**

   Conduct in-depth discussions with maintenance personnel to identify specific requirements and expectations for the Excel tool.

2. **Database Design and Development:**

   Initiate the development of the structured equipment database, incorporating feedback from the needs assessment.

3. **User Interface Prototyping:**

   Develop prototypes of the user interface to gather early feedback from end-users within the maintenance team.

**Phase 2: Development (Month 3-6)**

4. **Standardized Maintenance Plan Creation:**

   Continue the development process by focusing on the creation and storage of standardized preventive maintenance plans.

5. **Integration of Historical Data:**

   Work on integrating historical maintenance data into the tool, ensuring compatibility with existing systems.

6. **Automated Scheduling Algorithm and Alerts System:**

   Implement the automated scheduling algorithm and alerts system to ensure timely and proactive maintenance planning.

**Phase 3: Testing and Refinement (Month 7-8)**

7. **User Interface Refinement:**

   Refine the user interface based on feedback obtained during the testing phase, ensuring optimal usability.

8. **Comprehensive Testing:**

   Conduct extensive testing of the Excel tool, including pilot implementations with a select group of maintenance personnel.

9. **Bug Fixing and Optimization:**

   Address any identified bugs, optimize performance, and refine functionalities based on user feedback.

**Phase 4: Rollout and Training (Month 9-10)**

10. **Rollout Strategy:**

    Gradually roll out the Excel tool to the entire maintenance team, starting with a phased approach to ensure a smooth transition.

11. **Training Sessions:**

    Conduct hands-on training sessions for the workforce, covering aspects such as data entry, plan creation, scheduling, and utilizing the alerts system.

12. **Implementation Support:**

    Provide continuous support during the initial implementation phase to address any challenges and ensure effective use of the tool.

**Phase 5: Post-Implementation Evaluation (Month 11-12)**

13. **Performance Evaluation:**

    Evaluate the performance of the Excel tool based on user feedback, system analytics, and the achievement of predefined objectives.

14. **Adjustments and Further Training:**

    Make any necessary adjustments to the tool based on the post-implementation evaluation. Provide additional training as needed.

**Training Strategy for Existing Workforce:**

1. **Tailored Training Modules:**

   Develop training modules tailored to different skill levels within the maintenance team, ensuring that each user receives the specific knowledge needed for their role.

2. **Hands-On Workshops:**

   Conduct hands-on workshops where maintenance personnel can actively engage with the Excel tool. This approach facilitates practical learning and immediate application.

3. **Continuous Learning Sessions:**

   Establish a schedule for continuous learning sessions to address questions, provide additional tips, and showcase advanced features of the Excel tool.

4. **User Support System:**

   Implement a user support system, such as a dedicated helpdesk or online support portal, to address any queries or challenges faced by the workforce during the initial stages of implementation.

5. **Feedback Channels:**

   Create channels for ongoing feedback, encouraging maintenance personnel to share their experiences and suggest improvements. This feedback loop is crucial for refining the training approach and addressing any emerging issues.

By following this phased implementation plan and tailored training strategy, the brewery can ensure a smooth transition to the Excel-based preventive maintenance system. The focus on user involvement, feedback, and continuous improvement will contribute to the successful adoption of the tool within the existing workforce. In the subsequent section, we will explore the expected outcomes of implementing the Excel tool, outlining the benefits and positive impacts on preventive maintenance practices in the brewery.

## 4.10. Expected Outcomes of Implementing the Excel-Based Preventive Maintenance System

As the brewery prepares to integrate the Excel-based preventive maintenance system, a comprehensive set of anticipated benefits and outcomes foresees transformative changes in its maintenance practices. From standardized plans to proactive strategies and enhanced collaboration, these outcomes directly address existing challenges, offering a glimpse into a more efficient, streamlined, and proactive future.

**Anticipated Benefits and Outcomes:**

1. **Standardized and Comprehensive Preventive Maintenance Plans:**

   *Anticipated Outcome:* The Excel tool will enable the creation and storage of standardized preventive maintenance plans for each equipment category, ensuring a consistent and comprehensive approach to maintenance tasks.

2. **Efficient Automated Scheduling:**

   *Anticipated Outcome:* The automated scheduling algorithm will streamline the planning process, ensuring that preventive maintenance tasks are scheduled at optimal intervals. This efficiency will reduce downtime and enhance overall operational efficiency.

3. **Proactive Maintenance through Predictive Strategies:**

   *Anticipated Outcome:* By integrating historical maintenance data, the Excel tool will enable the implementation of predictive maintenance strategies. This proactive approach will reduce the reliance on reactive responses, minimizing unexpected breakdowns.

4. **Real-Time Monitoring and Alerts:**

   Anticipated Outcome: The tool's real-time data entry mechanisms and alerts system will enhance the monitoring of preventive maintenance activities. Automated notifications will ensure timely interventions, reducing the risk of critical component failures.

5. **Improved Resource Allocation:**

   *Anticipated Outcome:* The Excel tool's analytics and reporting features will provide insights into resource utilization, allowing for better planning and allocation of manpower, time, and spare parts. This improved resource management will contribute to cost-effectiveness.

6. **User-Friendly Interface for Broad Adoption:**

   *Anticipated Outcome:* The user-friendly interface will facilitate broad adoption within the existing workforce. This ease of use ensures that all team members, regardless of their level of experience, can actively engage with the preventive maintenance system.

7. **Enhanced Collaboration and Documentation:**

   *Anticipated Outcome:* The centralized nature of the Excel tool will enhance collaboration among team members. Documentation of maintenance activities will be streamlined, reducing the risk of knowledge gaps and ensuring a transfer of insights to newer team members.

8. **Customization and Adaptability:**

   *Anticipated Outcome:* The Excel tool's customization capabilities will allow the brewery to adapt the system to its specific needs. This adaptability ensures that the preventive maintenance system aligns with the diverse equipment categories present in the brewing environment.

**How These Outcomes Address Identified Issues:**

1. **Addressing Reactive Maintenance Culture:**

   The standardized plans and automated scheduling in the Excel tool shift the focus from reactive to proactive maintenance. Predictive strategies reduce reliance on reactive responses, addressing the current culture of firefighting.

2. **Consolidation and Standardization of Plans:**

   The tool facilitates the consolidation and standardization of preventive maintenance plans, addressing the existing challenge of disparate and undocumented approaches to maintenance across diverse equipment categories.

3. **Efficient Resource Allocation:**

   Improved resource allocation, enabled by the tool's analytics, reduces the current inefficiencies associated with ad-hoc responses. The system ensures that the right resources are allocated at the right time, minimizing downtime and optimizing costs.

4. **Enhanced Monitoring and Documentation:**

   Real-time monitoring and documentation within the Excel tool enhance visibility into maintenance activities. This addresses the challenge of a lack of systematic documentation and monitoring, contributing to improved accountability and knowledge transfer.

5. **Transition to Proactive Maintenance:**

   The integration of historical data and the implementation of predictive strategies signify a fundamental shift towards proactive maintenance. This addresses the current reliance on experienced personnel and reactive responses, promoting a more resilient and forward-thinking approach.

6. **User-Friendly Interface for Broader Adoption:**

   The user-friendly design ensures that the preventive maintenance system is accessible to the entire workforce. This addresses potential challenges related to resistance to change and fosters broad adoption of the new tool.

In conclusion, the implementation of the Excel-based preventive maintenance system is expected to yield a myriad of positive outcomes that directly address the identified challenges within the brewery's maintenance practices. By fostering a proactive, systematic, and collaborative approach, the Excel tool becomes a catalyst for optimizing preventive maintenance, ultimately contributing to increased equipment reliability, reduced downtime, and enhanced operational efficiency.

## 4.11. Conclusion

In this chapter, we embarked on a comprehensive exploration of the optimization of preventive maintenance processes within a brewery in Cyprus. The key points discussed can be summarized as follows:

1. **Review of Preventive Maintenance Issues:**

   The existing maintenance practices in the brewery were identified as predominantly reactive, lacking standardized plans, and relying heavily on the expertise of experienced mechanics. This reactive culture posed challenges in terms of resource allocation, documentation, and overall operational efficiency.

2. **Opportunities for Improvement:**

   Opportunities for improvement were identified, including the consolidation and standardization of maintenance plans, the implementation of predictive strategies, and the integration of condition-based monitoring systems. These opportunities aimed at transitioning from a reactive to a proactive maintenance approach.

3. **SWOT Analysis:**

   A SWOT analysis highlighted internal strengths and weaknesses, along with external opportunities and threats. The analysis guided the development of strategies to convert weaknesses into strengths and threats into opportunities, fostering a holistic approach to preventive maintenance.

4. **Reverse SWOT Analysis:**

   The reverse SWOT analysis focused on converting weaknesses and threats into strengths and opportunities. This strategic approach aimed at addressing challenges by leveraging existing strengths and turning potential threats into advantageous opportunities.

5. **Proposed Excel Tool:**

   The introduction of the Excel-based preventive maintenance tool emerged as a pivotal solution to address identified issues. The tool's structure includes a centralized equipment database, standardized maintenance plans, historical data integration, automated scheduling, alerts and notifications, and a user-friendly interface.

6. **Development Process:**

   The development process outlined various steps, from needs assessment and database design to testing, refinement, and eventual rollout. Anticipated challenges such as resistance to change, data integration complexity, technological hurdles, user adoption, and resource constraints were identified, with corresponding mitigation strategies.

7. **Implementation Plan:**

   The implementation plan delineated a phased approach, including pre-implementation activities, development, testing, rollout, and post-implementation evaluation. The training strategy for the existing workforce emphasized tailored training modules, hands-on workshops, continuous learning sessions, user support systems, and feedback channels.

8. **Expected Outcomes:**

   Anticipated benefits of implementing the Excel tool included standardized maintenance plans, efficient automated scheduling, proactive maintenance strategies, real-time monitoring and alerts, improved resource allocation, a user-friendly interface, enhanced collaboration and documentation, and customization and adaptability.

**Significance of the Proposed Excel Tool:**

The proposed Excel tool is of paramount significance for the brewery in Cyprus as it presents a transformative solution to the identified challenges in preventive maintenance. By automating and streamlining maintenance processes, the tool facilitates a shift from reactive to proactive strategies, fostering increased equipment reliability, reduced downtime, and enhanced operational efficiency. Its user-friendly design ensures broad adoption within the existing workforce, contributing to a culture of continuous improvement and knowledge transfer. In essence, the Excel tool emerges as a catalyst for optimization, aligning maintenance practices with industry best standards and positioning the brewery for sustained success in a competitive brewing landscape.

# Chapter 5

# Methodology

**Introduction:**

The methodology adopted for this research is designed to methodically collect, analyze, and interpret essential information with the goal of optimizing preventive maintenance processes within the brewery in Cyprus. The approach comprises distinct stages, each meticulously crafted to extract specific data and insights critical for comprehending the existing landscape of maintenance practices. The ultimate objective is to inform the development of a robust and user-friendly Excel tool that will revolutionize the way preventive maintenance is managed in the brewery. By integrating both qualitative and quantitative data, this methodology seeks to provide a comprehensive understanding of the challenges and opportunities in the current maintenance framework. Through a structured and systematic approach, this research methodology lays the foundation for an innovative tool that promises to enhance the efficiency and effectiveness of maintenance operations, contributing to the operational excellence of the brewery.

## 5.1. Needs Assessment:

In this section, the focus is on conducting a thorough Needs Assessment to discern the specific requirements, challenges, and expectations inherent in the preventive maintenance processes of the brewery. The primary goal is to lay the groundwork for developing a tailored Excel tool that effectively addresses the distinctive needs of the brewery's maintenance framework.

**Methods:**

1. **Conducting Interviews**: In-depth interviews will be the cornerstone of gathering insights from maintenance personnel at various hierarchical levels within the brewery. This method ensures a comprehensive exploration of individual perspectives and challenges, providing a nuanced understanding across organizational ranks.
2. **Facilitating Focus Group Discussions:** Organizing focus group discussions will foster collaborative input. By bringing together a diverse group of maintenance personnel, these sessions create a platform for collective brainstorming and the exchange of ideas. The interactive nature encourages participants to build upon each other's experiences, offering a holistic view of prevailing challenges and expectations.
3. **Administering Surveys**: Surveys will complement qualitative data by gathering quantitative insights. Designed to elicit specific information on perceived challenges and expectations related to preventive maintenance, surveys provide a structured format for systematic data collection. This approach enables a quantitative analysis of trends and patterns.

Through this multi-method approach of interviews, focus groups, and surveys, the Needs Assessment phase aims to triangulate data from diverse sources. This triangulation ensures a comprehensive and nuanced understanding of the maintenance landscape within the brewery, laying a solid foundation for subsequent stages in the development of the Excel tool.

## 5.2. Current State Analysis:

In this section, the objective is to conduct a comprehensive Current State Analysis, seeking a profound understanding of the existing preventive maintenance practices within the brewery and their impact on operational efficiency. The aim is to identify areas of improvement and provide insights that will inform the development of a targeted Excel tool.

**Methods:**

1. **Review of Historical Maintenance Records:** An exhaustive examination of historical maintenance records and breakdown reports will be conducted. This entails delving into past maintenance activities to identify recurring issues, patterns, and trends. Through this retrospective analysis, the research aims to uncover historical challenges and areas where preventive maintenance might have fallen short.
2. **On-Site Observations:** On-site observations will be carried out to assess the actual execution of preventive maintenance tasks. This method involves firsthand observation of maintenance procedures and workflows, allowing for a qualitative assessment of the adherence to documented protocols, potential bottlenecks, and the overall effectiveness of current practices.
3. **Analysis of Existing Documentation and Manuals:** The study will involve a meticulous analysis of existing documentation and manuals related to maintenance procedures. This includes standard operating procedures, equipment manuals, and any other relevant documentation. The objective is to evaluate the clarity, comprehensiveness, and practicality of the existing guidance available to maintenance personnel.

By employing a combination of record reviews, on-site observations, and documentation analysis, the Current State Analysis aims to provide a holistic view of the brewery's preventive maintenance practices. This comprehensive understanding serves as a critical foundation for proposing targeted improvements and enhancements through the subsequent stages of the Excel tool development.

## 5.3. SWOT Analysis:

This section aims to conduct a SWOT Analysis to comprehensively evaluate both internal and external factors influencing preventive maintenance within the brewery. The strategic assessment seeks to identify internal strengths and weaknesses, as well as external opportunities and threats, providing a nuanced understanding of the brewery's current position in the maintenance landscape.

**Methods:**

1. **Workshops with Key Stakeholders:** Facilitating workshops with key stakeholders, including maintenance personnel, operational leaders, and relevant decision-makers, forms a central part of the SWOT Analysis. These collaborative sessions will elicit insights into internal strengths and weaknesses, drawing on the collective expertise and perspectives of those directly involved in or impacted by the brewery's maintenance practices.
2. **Review of Industry Trends and External Factors:** A thorough review of industry trends and external factors influencing maintenance practices will be conducted. This involves analyzing broader economic, technological, and regulatory trends, as well as advancements in maintenance methodologies within the brewing industry. Understanding these external dynamics provides context for identifying opportunities and threats.
3. **Collaboration with Cross-Functional Teams:** Collaborative engagement with cross-functional teams will be fostered to assess potential opportunities and threats. By involving individuals from various departments, such as production, technology, and quality control, a holistic perspective on the external factors influencing maintenance can be gained. This collaboration ensures a comprehensive exploration of factors beyond the immediate maintenance realm.

Through these methods, the SWOT Analysis seeks to uncover insights that contribute to a strategic understanding of the brewery's maintenance landscape. By identifying internal strengths to leverage, addressing weaknesses, capitalizing on external opportunities, and mitigating threats, this analysis sets the stage for the development of a preventive maintenance approach aligned with both internal capabilities and external realities.

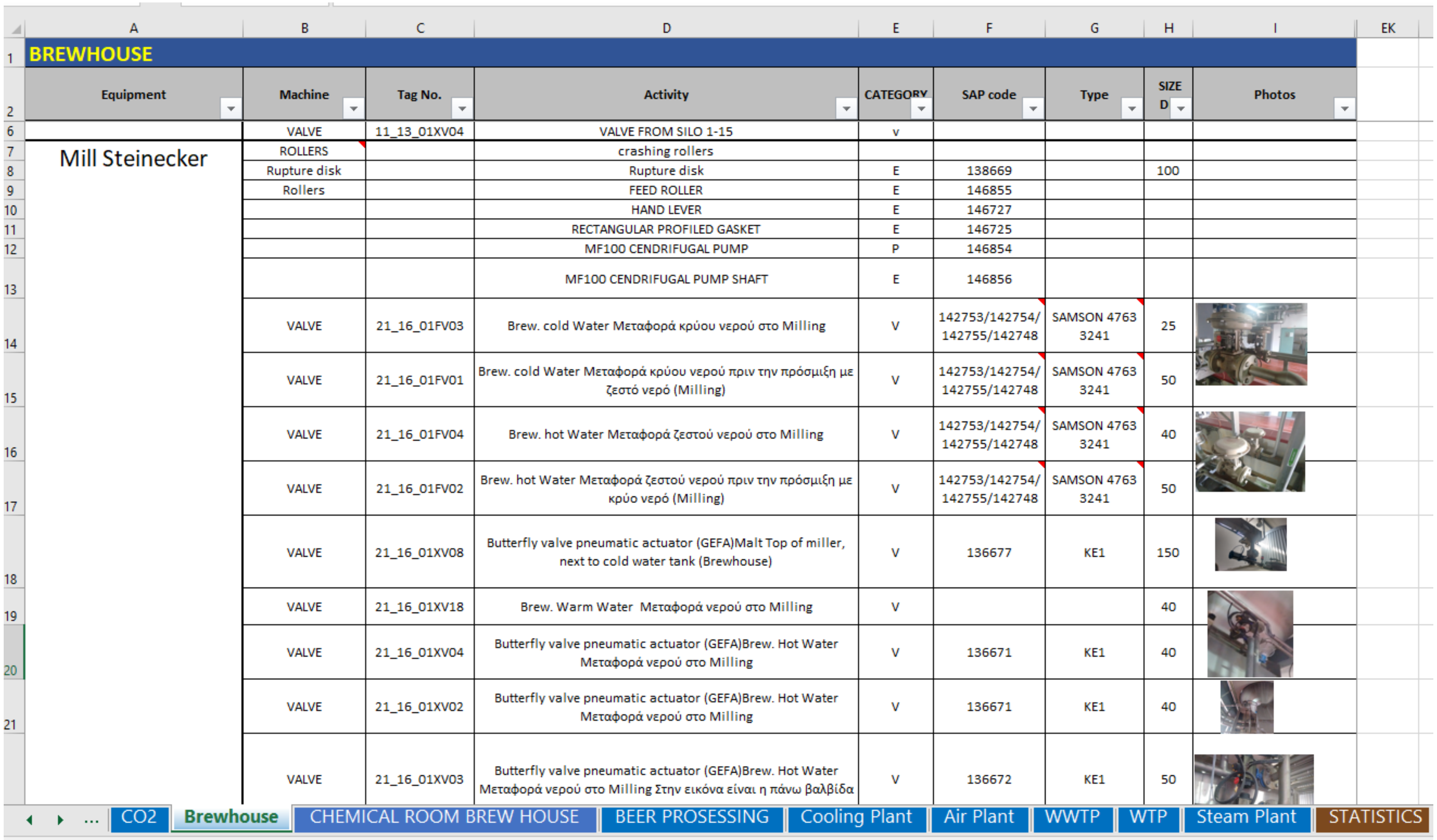
## 5.4. Data Collection for Excel Tool Development:

This section aims to outline the methods employed in the Data Collection phase, a pivotal step for gathering the necessary information to structure the Excel tool effectively. The objective is to acquire detailed insights into equipment specifications, maintenance plans, historical data, and user preferences, establishing a comprehensive database that forms the backbone of the Excel tool and facilitates precise and targeted preventive maintenance strategies.

**Methods:**

1. **Detailed Equipment Inventory:** Creation of a detailed inventory of all equipment is a foundational step. This inventory includes specifications and critical components of each machine involved in the brewing process. This comprehensive database serves as the cornerstone for mapping out preventive maintenance schedules and ensuring that every critical area is accounted for within the Excel tool.
2. **Collaboration with Maintenance Teams:** Close collaboration with maintenance teams is crucial to extract information from existing plans, manuals, and historical records. By tapping into the expertise of those directly involved in equipment maintenance, the Excel tool can be fine-tuned to address the specific needs and challenges identified during the Needs Assessment phase. This collaboration ensures that the tool is not only comprehensive but also practical for daily use.
3. **Surveys to Gather User Insights:** Surveys will be utilized to gather insights on preferred functionalities and user interface features. Understanding the preferences of end-users, particularly maintenance personnel, ensures that the Excel tool is user-friendly, efficient, and aligns with the workflows of those responsible for its implementation. This method contributes to the tool's usability and acceptance within the brewery.

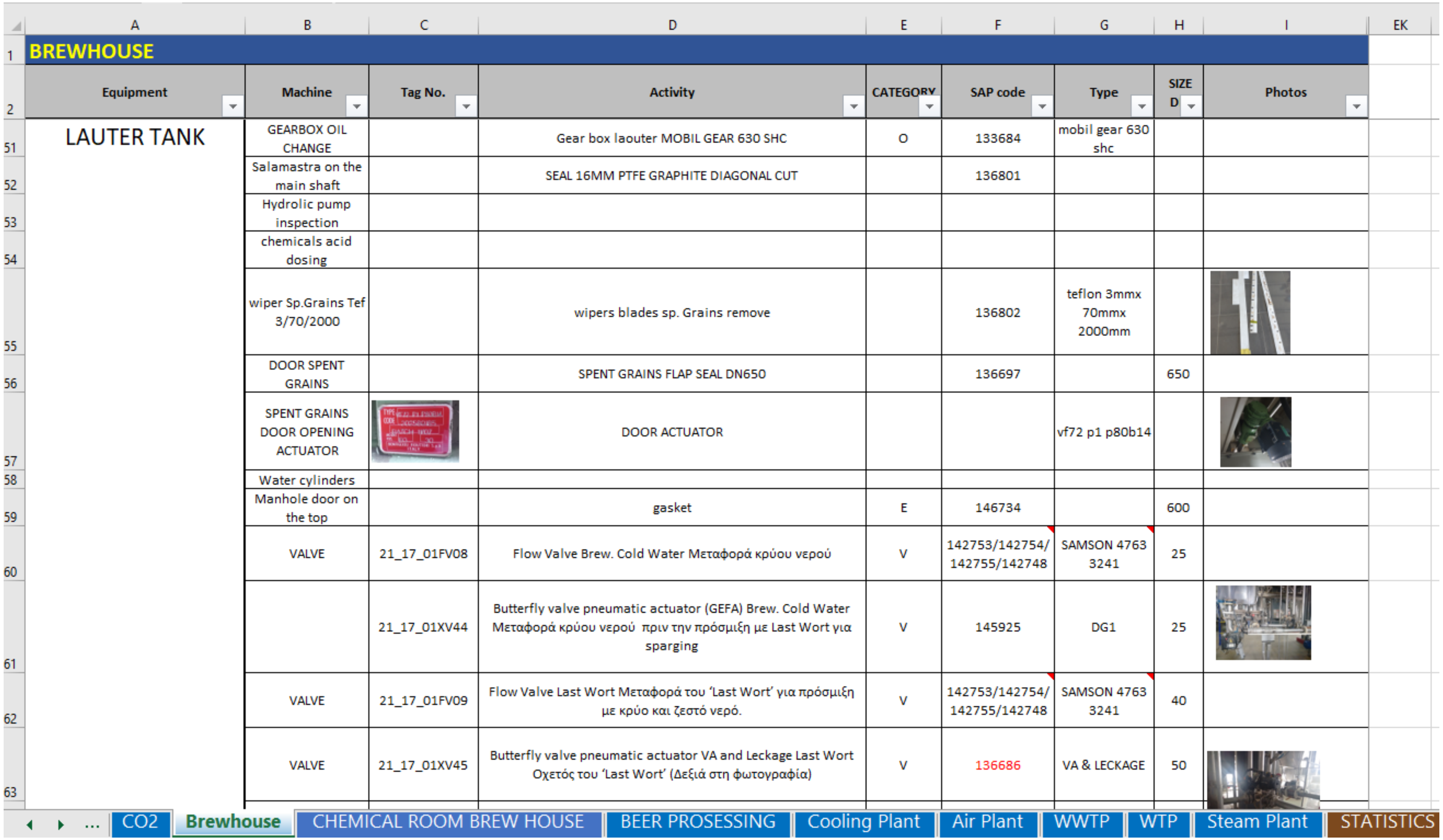
**Excel Tool Main Layout:** The main layout of the Excel tool encompasses tabs for critical areas such as Brew House, Beer Processing, Steam, CO2 Plant, WTP (Water Treatment Plant), WWTP (Waste Water Treatment Plant), and more. Each tab serves as a dedicated database containing vital information about the respective machines and processes.



BREWHOUSE

| Equipment | Machine | Tag No. | Activity | CATEGORY | SAP code | Type | SIZE D | Photos |
|---|---|---|---|---|---|---|---|---|
|  | VALVE | 11_13_01XV04 | VALVE FROM SILO 1-15 | v |  |  |  |  |
| Mill Steinecker | ROLLERS |  | crashing rollers |  |  |  |  |  |
|  | Rupture disk |  | Rupture disk | E | 138669 |  | 100 |  |
|  | Rollers |  | FEED ROLLER | E | 146855 |  |  |  |
|  |  |  | HAND LEVER | E | 146727 |  |  |  |
|  |  |  | RECTANGULAR PROFILED GASKET | E | 146725 |  |  |  |
|  |  |  | MF100 CENDRIFUGAL PUMP | P | 146854 |  |  |  |
|  |  |  | MF100 CENDRIFUGAL PUMP SHAFT | E | 146856 |  |  |  |
|  | VALVE | 21_16_01FV03 | Brew. cold Water Μεταφορά κρύου νερού στο Milling | V | 142753/142754/ 142755/142748 | SAMSON 4763 3241 | 25 |  |
|  | VALVE | 21_16_01FV01 | Brew. cold Water Μεταφορά κρύου νερού πριν την πρόσμιξη με ζεστό νερό (Milling) | V | 142753/142754/ 142755/142748 | SAMSON 4763 3241 | 50 |  |
|  | VALVE | 21_16_01FV04 | Brew. hot Water Μεταφορά ζεστού νερού στο Milling | V | 142753/142754/ 142755/142748 | SAMSON 4763 3241 | 40 |  |
|  | VALVE | 21_16_01FV02 | Brew. hot Water Μεταφορά ζεστού νερού πριν την πρόσμιξη με κρύο νερό (Milling) | V | 142753/142754/ 142755/142748 | SAMSON 4763 3241 | 50 |  |
|  | VALVE | 21_16_01XV08 | Butterfly valve pneumatic actuator (GEFA)Malt Top of miller, next to cold water tank (Brewhouse) | V | 136677 | KE1 | 150 |  |
|  | VALVE | 21_16_01XV18 | Brew. Warm Water Μεταφορά νερού στο Milling | V |  |  | 40 |  |
|  | VALVE | 21_16_01XV04 | Butterfly valve pneumatic actuator (GEFA)Brew. Hot Water Μεταφορά νερού στο Milling | V | 136671 | KE1 | 40 |  |
|  | VALVE | 21_16_01XV02 | Butterfly valve pneumatic actuator (GEFA)Brew. Hot Water Μεταφορά νερού στο Milling | V | 136671 | KE1 | 40 |  |
|  | VALVE | 21_16_01XV03 | Butterfly valve pneumatic actuator (GEFA)Brew. Hot Water Μεταφορά νερού στο Milling Στην εικόνα είναι η πάνω βαλβίδα | V | 136672 | KE1 | 50 |  |

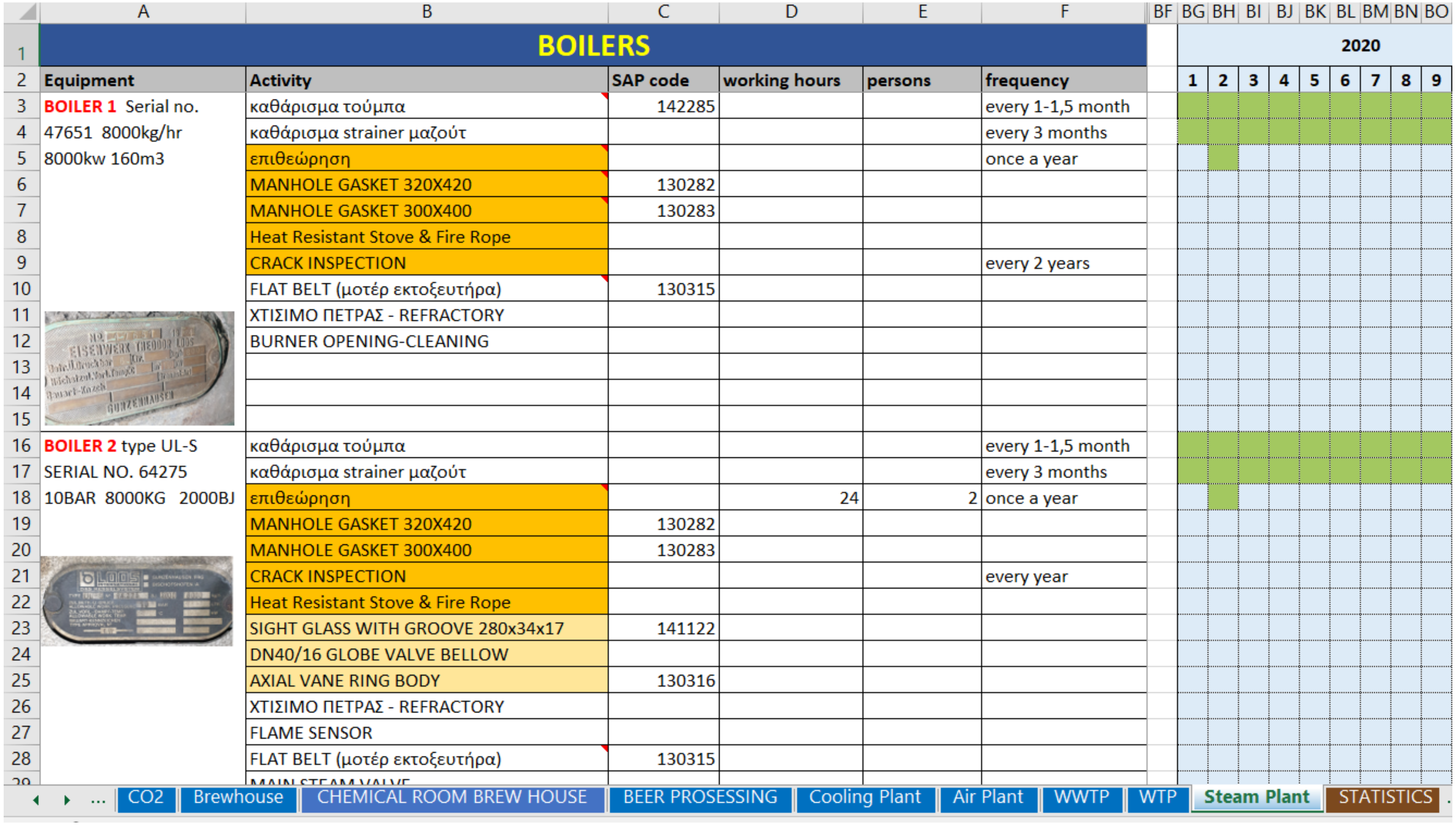
*Picture 23 Brew House Mill Area*



BREWHOUSE

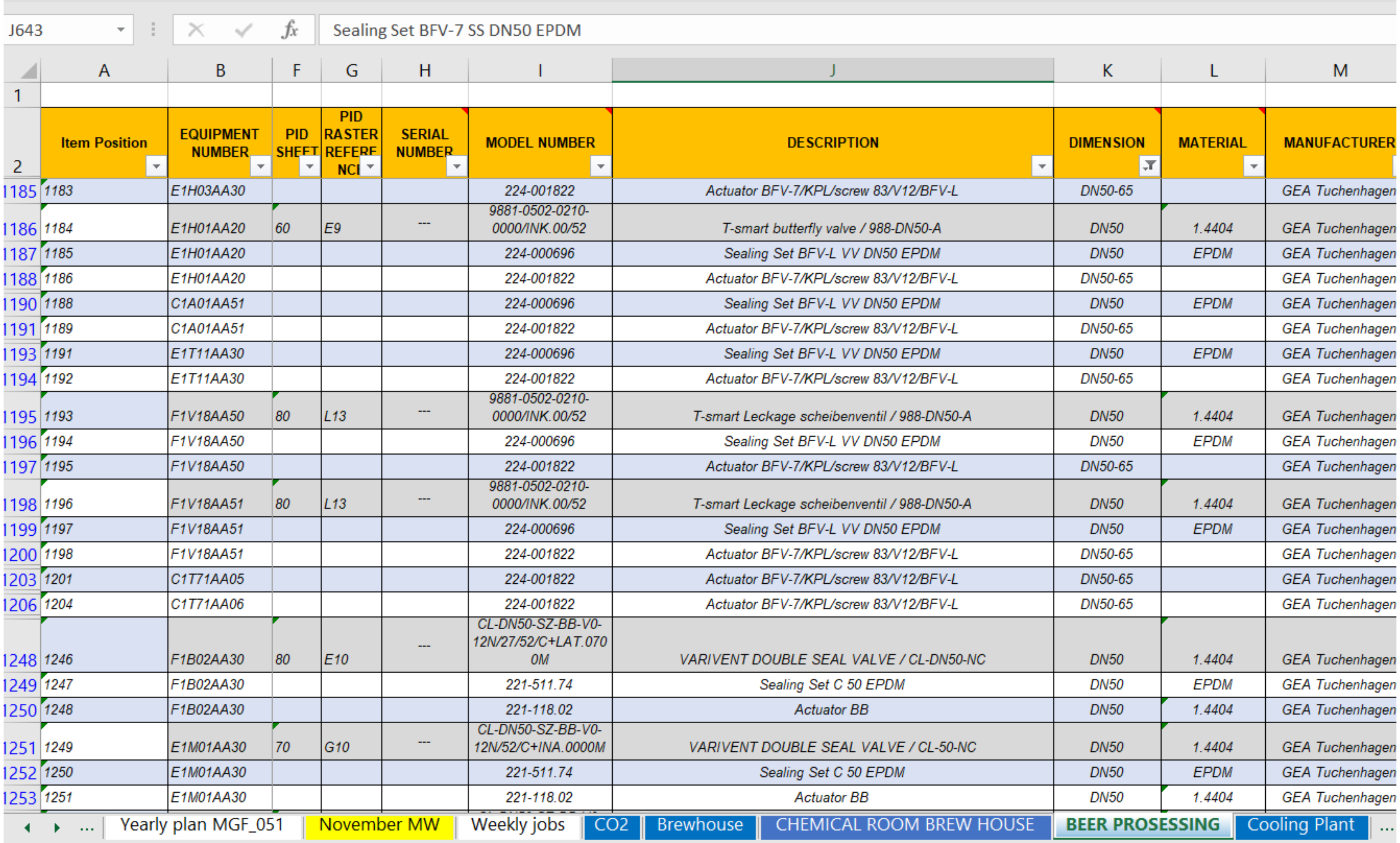
| | Equipment | Machine | Tag No. | Activity | CATEGORY | SAP code | Type | SIZE D | Photos |
|---|---|---|---|---|---|---|---|---|---|
| 51 | LAUTER TANK | GEARBOX OIL CHANGE | | Gear box laouter MOBIL GEAR 630 SHC | O | 133684 | mobil gear 630 shc | | |
| 52 | | Salamastra on the main shaft | | SEAL 16MM PTFE GRAPHITE DIAGONAL CUT | | 136801 | | | |
| 53 | | Hydrolic pump inspection | | | | | | | |
| 54 | | chemicals acid dosing | | | | | | | |
| 55 | | wiper Sp.Grains Tef 3/70/2000 | | wipers blades sp. Grains remove | | 136802 | teflon 3mmx 70mmx 2000mm | | |
| 56 | | DOOR SPENT GRAINS | | SPENT GRAINS FLAP SEAL DN650 | | 136697 | | 650 | |
| 57 | | SPENT GRAINS DOOR OPENING ACTUATOR | | DOOR ACTUATOR | | | vf72 p1 p80b14 | | |
| 58 | | Water cylinders | | | | | | | |
| 59 | | Manhole door on the top | | gasket | E | 146734 | | 600 | |
| 60 | | VALVE | 21_17_01FV08 | Flow Valve Brew. Cold Water Μεταφορά κρύου νερού | V | 142753/142754/<br>142755/142748 | SAMSON 4763 3241 | 25 | |
| 61 | | | 21_17_01XV44 | Butterfly valve pneumatic actuator (GEFA) Brew. Cold Water Μεταφορά κρύου νερού πριν την πρόσμιξη με Last Wort για sparging | V | 145925 | DG1 | 25 | |
| 62 | | VALVE | 21_17_01FV09 | Flow Valve Last Wort Μεταφορά του 'Last Wort' για πρόσμιξη με κρύο και ζεστό νερό. | V | 142753/142754/<br>142755/142748 | SAMSON 4763 3241 | 40 | |
| 63 | | VALVE | 21_17_01XV45 | Butterfly valve pneumatic actuator VA and Leckage Last Wort Οχετός του 'Last Wort' (Δεξιά στη φωτογραφία) | V | 136686 | VA & LECKAGE | 50 | |

*Picture 24 Brew House Lauter Tank Area*



| | A | B | C | D | E | F | BF | BG | BH | BI | BJ | BK | BL | BM | BN | BO |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | **BOILERS** | | | | | | | **2020** | | | | | | | | |
| 2 | **Equipment** | **Activity** | **SAP code** | **working hours** | **persons** | **frequency** | | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** |
| 3 | **BOILER 1** Serial no. | καθάρισμα τούμπα | 142285 | | | every 1-1,5 month | | 🟩 | 🟩 | 🟩 | 🟩 | 🟩 | 🟩 | 🟩 | 🟩 | 🟩 |
| 4 | 47651 8000kg/hr | καθάρισμα strainer μαζούτ | | | | every 3 months | | 🟩 | 🟩 | 🟩 | 🟩 | 🟩 | 🟩 | 🟩 | 🟩 | 🟩 |
| 5 | 8000kw 160m3 | επιθεώρηση | | | | once a year | | | 🟩 | | | | | | | |
| 6 | | MANHOLE GASKET 320X420 | 130282 | | | | | | | | | | | | | |
| 7 | | MANHOLE GASKET 300X400 | 130283 | | | | | | | | | | | | | |
| 8 | | Heat Resistant Stove & Fire Rope | | | | | | | | | | | | | | |
| 9 | | CRACK INSPECTION | | | | every 2 years | | | | | | | | | | |
| 10 | | FLAT BELT (μοτέρ εκτοξευτήρα) | 130315 | | | | | | | | | | | | | |
| 11 | | ΧΤΙΣΙΜΟ ΠΕΤΡΑΣ - REFRACTORY | | | | | | | | | | | | | | |
| 12 | | BURNER OPENING-CLEANING | | | | | | | | | | | | | | |
| 13 | | | | | | | | | | | | | | | | |
| 14 | | | | | | | | | | | | | | | | |
| 15 | | | | | | | | | | | | | | | | |
| 16 | **BOILER 2** type UL-S | καθάρισμα τούμπα | | | | every 1-1,5 month | | 🟩 | 🟩 | 🟩 | 🟩 | 🟩 | 🟩 | 🟩 | 🟩 | 🟩 |
| 17 | SERIAL NO. 64275 | καθάρισμα strainer μαζούτ | | | | every 3 months | | 🟩 | 🟩 | 🟩 | 🟩 | 🟩 | 🟩 | 🟩 | 🟩 | 🟩 |
| 18 | 10BAR 8000KG 2000BJ | επιθεώρηση | | 24 | 2 | once a year | | | 🟩 | | | | | | | |
| 19 | | MANHOLE GASKET 320X420 | 130282 | | | | | | | | | | | | | |
| 20 | | MANHOLE GASKET 300X400 | 130283 | | | | | | | | | | | | | |
| 21 | | CRACK INSPECTION | | | | every year | | | | | | | | | | |
| 22 | | Heat Resistant Stove & Fire Rope | | | | | | | | | | | | | | |
| 23 | | SIGHT GLASS WITH GROOVE 280x34x17 | 141122 | | | | | | | | | | | | | |
| 24 | | DN40/16 GLOBE VALVE BELLOW | | | | | | | | | | | | | | |
| 25 | | AXIAL VANE RING BODY | 130316 | | | | | | | | | | | | | |
| 26 | | ΧΤΙΣΙΜΟ ΠΕΤΡΑΣ - REFRACTORY | | | | | | | | | | | | | | |
| 27 | | FLAME SENSOR | | | | | | | | | | | | | | |
| 28 | | FLAT BELT (μοτέρ εκτοξευτήρα) | 130315 | | | | | | | | | | | | | |
| 29 | | MAIN STEAM VALVE | | | | | | | | | | | | | | |

*Picture 25 Steam Plant Boiler Area*

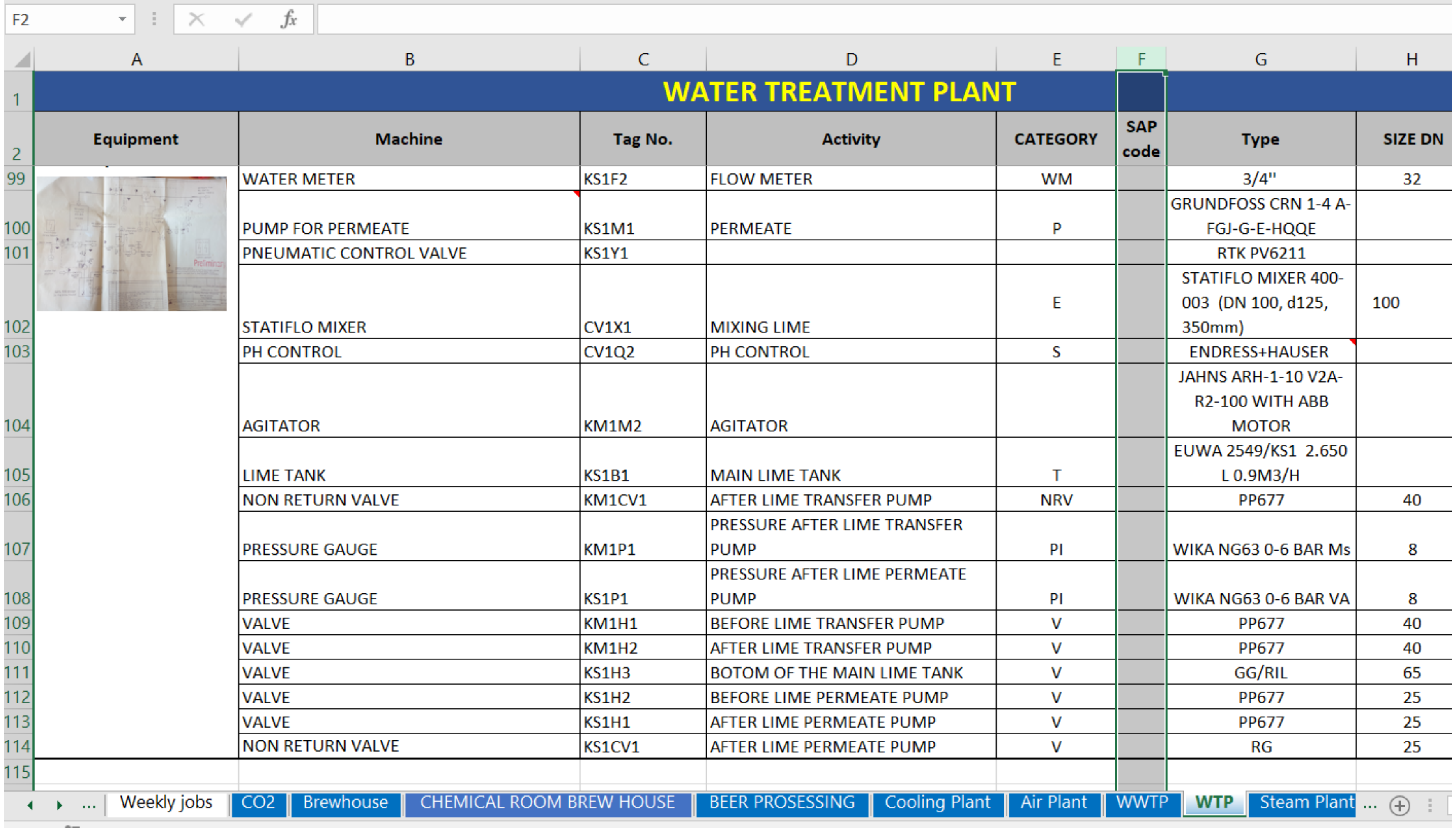


J643

Sealing Set BFV-7 SS DN50 EPDM

| | A | B | F | G | H | I | J | K | L | M |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | | | | | | | |
| 2 | Item Position | EQUIPMENT NUMBER | PID SHEET | PID RASTER REFERENCE | SERIAL NUMBER | MODEL NUMBER | DESCRIPTION | DIMENSION | MATERIAL | MANUFACTURER |
| 1185 | 1183 | E1H03AA30 | | | | 224-001822 | Actuator BFV-7/KPL/screw 83/V12/BFV-L | DN50-65 | | GEA Tuchenhagen |
| 1186 | 1184 | E1H01AA20 | 60 | E9 | --- | 9881-0502-0210-0000/INK.00/52 | T-smart butterfly valve / 988-DN50-A | DN50 | 1.4404 | GEA Tuchenhagen |
| 1187 | 1185 | E1H01AA20 | | | | 224-000696 | Sealing Set BFV-L VV DN50 EPDM | DN50 | EPDM | GEA Tuchenhagen |
| 1188 | 1186 | E1H01AA20 | | | | 224-001822 | Actuator BFV-7/KPL/screw 83/V12/BFV-L | DN50-65 | | GEA Tuchenhagen |
| 1190 | 1188 | C1A01AA51 | | | | 224-000696 | Sealing Set BFV-L VV DN50 EPDM | DN50 | EPDM | GEA Tuchenhagen |
| 1191 | 1189 | C1A01AA51 | | | | 224-001822 | Actuator BFV-7/KPL/screw 83/V12/BFV-L | DN50-65 | | GEA Tuchenhagen |
| 1193 | 1191 | E1T11AA30 | | | | 224-000696 | Sealing Set BFV-L VV DN50 EPDM | DN50 | EPDM | GEA Tuchenhagen |
| 1194 | 1192 | E1T11AA30 | | | | 224-001822 | Actuator BFV-7/KPL/screw 83/V12/BFV-L | DN50-65 | | GEA Tuchenhagen |
| 1195 | 1193 | F1V18AA50 | 80 | L13 | --- | 9881-0502-0210-0000/INK.00/52 | T-smart Leckage scheibenventil / 988-DN50-A | DN50 | 1.4404 | GEA Tuchenhagen |
| 1196 | 1194 | F1V18AA50 | | | | 224-000696 | Sealing Set BFV-L VV DN50 EPDM | DN50 | EPDM | GEA Tuchenhagen |
| 1197 | 1195 | F1V18AA50 | | | | 224-001822 | Actuator BFV-7/KPL/screw 83/V12/BFV-L | DN50-65 | | GEA Tuchenhagen |
| 1198 | 1196 | F1V18AA51 | 80 | L13 | --- | 9881-0502-0210-0000/INK.00/52 | T-smart Leckage scheibenventil / 988-DN50-A | DN50 | 1.4404 | GEA Tuchenhagen |
| 1199 | 1197 | F1V18AA51 | | | | 224-000696 | Sealing Set BFV-L VV DN50 EPDM | DN50 | EPDM | GEA Tuchenhagen |
| 1200 | 1198 | F1V18AA51 | | | | 224-001822 | Actuator BFV-7/KPL/screw 83/V12/BFV-L | DN50-65 | | GEA Tuchenhagen |
| 1203 | 1201 | C1T71AA05 | | | | 224-001822 | Actuator BFV-7/KPL/screw 83/V12/BFV-L | DN50-65 | | GEA Tuchenhagen |
| 1206 | 1204 | C1T71AA06 | | | | 224-001822 | Actuator BFV-7/KPL/screw 83/V12/BFV-L | DN50-65 | | GEA Tuchenhagen |
| 1248 | 1246 | F1B02AA30 | 80 | E10 | --- | CL-DN50-SZ-BB-V0-12N/27/52/C+LAT.070 0M | VARIVENT DOUBLE SEAL VALVE / CL-DN50-NC | DN50 | 1.4404 | GEA Tuchenhagen |
| 1249 | 1247 | F1B02AA30 | | | | 221-511.74 | Sealing Set C 50 EPDM | DN50 | EPDM | GEA Tuchenhagen |
| 1250 | 1248 | F1B02AA30 | | | | 221-118.02 | Actuator BB | DN50 | 1.4404 | GEA Tuchenhagen |
| 1251 | 1249 | E1M01AA30 | 70 | G10 | --- | CL-DN50-SZ-BB-V0-12N/52/C+INA.0000M | VARIVENT DOUBLE SEAL VALVE / CL-50-NC | DN50 | 1.4404 | GEA Tuchenhagen |
| 1252 | 1250 | E1M01AA30 | | | | 221-511.74 | Sealing Set C 50 EPDM | DN50 | EPDM | GEA Tuchenhagen |
| 1253 | 1251 | E1M01AA30 | | | | 221-118.02 | Actuator BB | DN50 | 1.4404 | GEA Tuchenhagen |

*Picture 26 Beer Processing Area*



WATER TREATMENT PLANT

| | Equipment | Machine | Tag No. | Activity | CATEGORY | SAP code | Type | SIZE DN |
|---|---|---|---|---|---|---|---|---|
| 99 | | WATER METER | KS1F2 | FLOW METER | WM | | 3/4" | 32 |
| 100 | | PUMP FOR PERMEATE | KS1M1 | PERMEATE | P | | GRUNDFOSS CRN 1-4 A-FGJ-G-E-HQQE | |
| 101 | | PNEUMATIC CONTROL VALVE | KS1Y1 | | | | RTK PV6211 | |
| 102 | | STATIFLO MIXER | CV1X1 | MIXING LIME | E | | STATIFLO MIXER 400-003 (DN 100, d125, 350mm) | 100 |
| 103 | | PH CONTROL | CV1Q2 | PH CONTROL | S | | ENDRESS+HAUSER | |
| 104 | | AGITATOR | KM1M2 | AGITATOR | | | JAHNS ARH-1-10 V2A-R2-100 WITH ABB MOTOR | |
| 105 | | LIME TANK | KS1B1 | MAIN LIME TANK | T | | EUWA 2549/KS1 2.650 L 0.9M3/H | |
| 106 | | NON RETURN VALVE | KM1CV1 | AFTER LIME TRANSFER PUMP | NRV | | PP677 | 40 |
| 107 | | PRESSURE GAUGE | KM1P1 | PRESSURE AFTER LIME TRANSFER PUMP | PI | | WIKA NG63 0-6 BAR Ms | 8 |
| 108 | | PRESSURE GAUGE | KS1P1 | PRESSURE AFTER LIME PERMEATE PUMP | PI | | WIKA NG63 0-6 BAR VA | 8 |
| 109 | | VALVE | KM1H1 | BEFORE LIME TRANSFER PUMP | V | | PP677 | 40 |
| 110 | | VALVE | KM1H2 | AFTER LIME TRANSFER PUMP | V | | PP677 | 40 |
| 111 | | VALVE | KS1H3 | BOTOM OF THE MAIN LIME TANK | V | | GG/RIL | 65 |
| 112 | | VALVE | KS1H2 | BEFORE LIME PERMEATE PUMP | V | | PP677 | 25 |
| 113 | | VALVE | KS1H1 | AFTER LIME PERMEATE PUMP | V | | PP677 | 25 |
| 114 | | NON RETURN VALVE | KS1CV1 | AFTER LIME PERMEATE PUMP | V | | RG | 25 |
| 115 | | | | | | | | |

*Picture 27 Water Treatment Plant*

By integrating these diverse methods, the Data Collection phase sets the stage for developing an Excel tool tailored to the specific needs and nuances of the brewery's preventive maintenance requirements.

## 5.5. Pilot Implementation:

The Pilot Implementation phase is a pivotal step in the Excel tool development process, providing a controlled environment for testing and refining the proposed tool before full-scale deployment. This section outlines the methods employed during the pilot phase to comprehensively assess the tool's functionality, user-friendliness, and overall effectiveness.

**Methods:**

1. **Small-Scale Implementation:** The Excel tool will be implemented on a small scale, involving a select group of maintenance personnel. This controlled environment allows for a focused assessment of the tool's performance, ensuring that any issues or challenges are identified and addressed before broader implementation.

2. **Feedback Collection:** Feedback will be collected through a combination of surveys, interviews, and observation during the pilot phase. Surveys will capture quantitative insights, while interviews provide qualitative perspectives from users. Direct observation of users interacting with the tool adds an additional layer of understanding, allowing for a comprehensive assessment of the tool's usability and practicality.

3. **Regular Review Meetings:** Regular review meetings will be conducted throughout the pilot phase to address challenges and gather ongoing feedback from users. These meetings serve as a forum for users to express their experiences, highlight any difficulties encountered, and propose suggestions for improvements. The iterative nature of these reviews ensures continuous refinement of the Excel tool based on real-world user experiences.

## 5.6 Describe the functions of the excel tool

Following the detailed description of the Excel tool's functions, it is essential to underscore how these features collectively contribute to a robust preventive maintenance system, promoting efficiency, resource optimization, and comprehensive task management.

### 5.6.1. Yearly Maintenance Plan:

In the Yearly Maintenance Plan tab, comprehensive details are not limited to just the schedule of maintenance tasks. This tab also serves as a database containing information about the working hours required for each job and the necessary manpower. By incorporating data on labor requirements, the tab becomes an invaluable resource for planning and allocating human resources efficiently. This feature allows maintenance teams to anticipate the manpower needs for each maintenance or service task, facilitating better preparation and resource management. In essence, the Yearly Maintenance Plan tab provides a holistic overview of the entire maintenance schedule, encompassing not only the tasks but also the time and human resources required, ensuring a well-prepared and optimized approach to preventive maintenance.

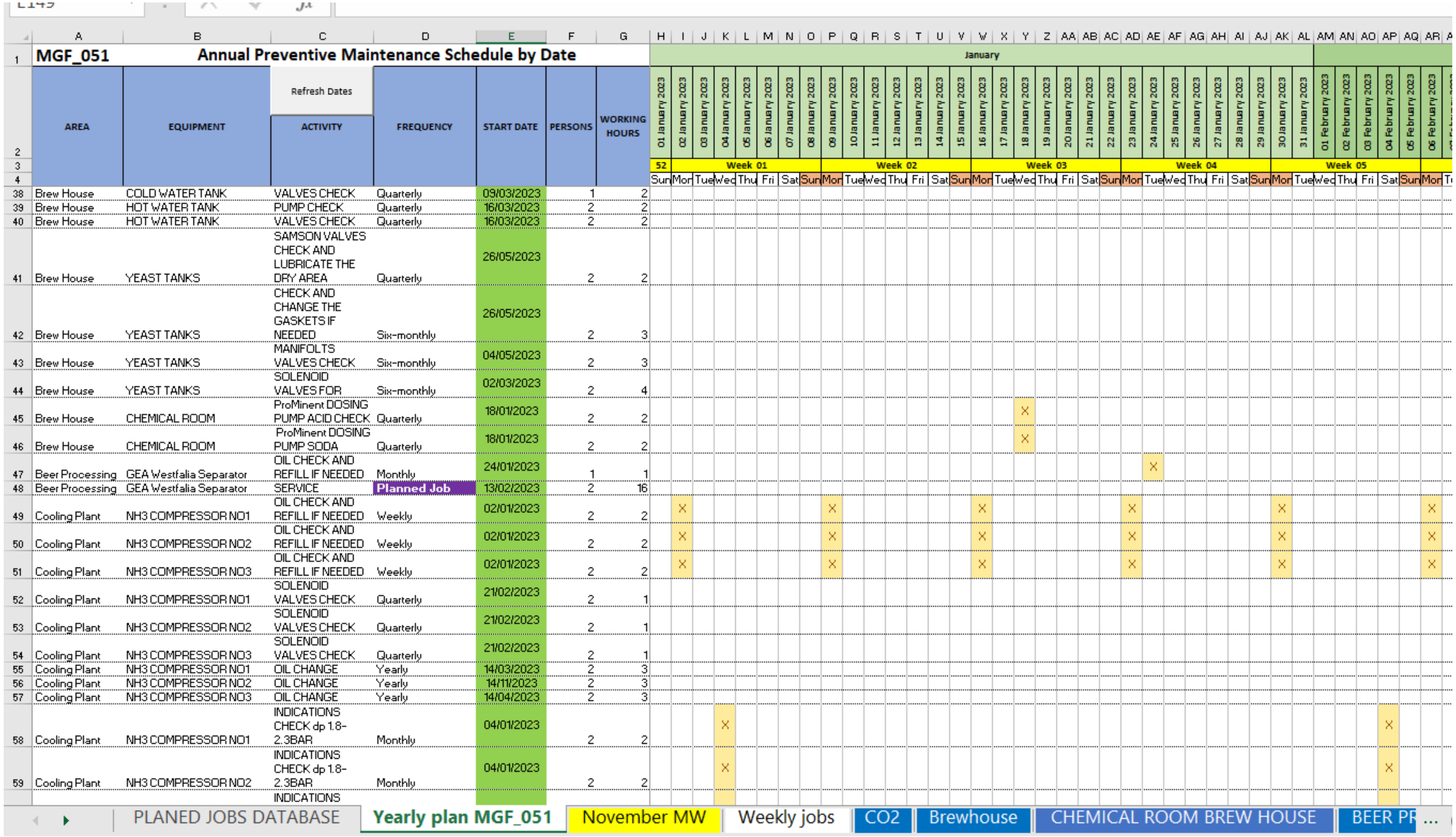
### 5.6.2. Weekly Maintenance Program

A key enhancement in the Excel tool is its ability to automatically generate a Weekly Maintenance Program. This feature streamlines the planning process by dynamically incorporating data from the Yearly Maintenance Plan. The tool takes into account job descriptions, estimated working hours, and required manpower for each task. By leveraging this information, the Excel tool autonomously generates a weekly schedule, providing a detailed and organized plan for maintenance activities.

This automation not only saves time but also ensures accuracy and efficiency in planning. The Weekly Maintenance Program becomes a practical tool for supervisors and maintenance teams, offering a clear and structured overview of tasks for the upcoming week, promoting effective resource allocation, and enhancing overall maintenance planning.

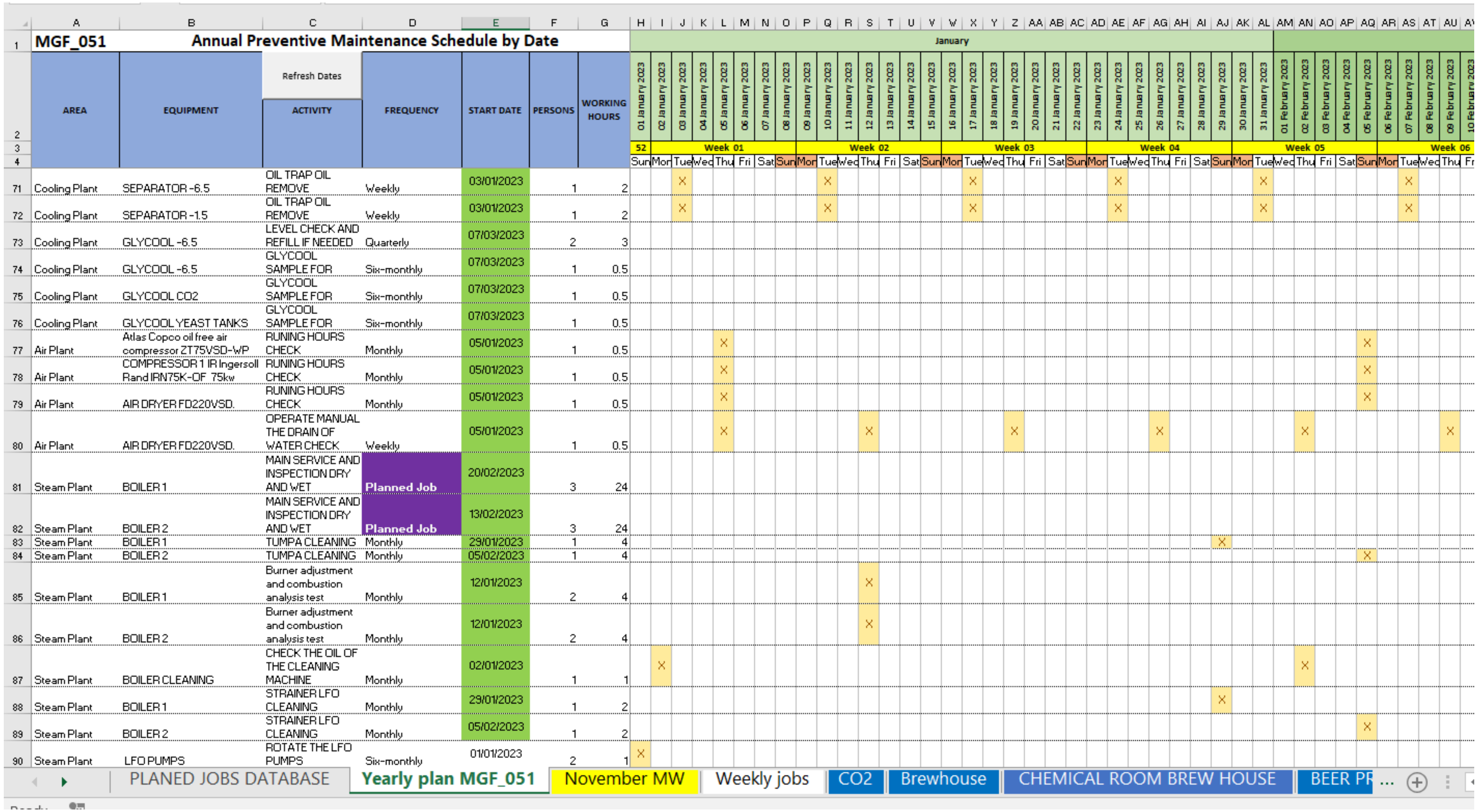
### 5.6.3 Planed Jobs Database

Apart from the automated Weekly Maintenance Program, another significant function of the Excel tool is the establishment of a Planned Jobs Database. This database is designed to accommodate non-standard jobs that arise during the year, such as projects or unforeseen malfunctions. The tool includes a dedicated tab where these jobs can be entered, providing a centralized repository for planning and tracking purposes. Each entry in the Planned Jobs Database includes critical details such as job description, estimated working hours, required manpower, and, importantly, the criticality level. This criticality assessment aids in prioritizing and scheduling these non-routine jobs effectively, ensuring that resources are allocated based on the urgency and impact of each task. The Planned Jobs Database enhances the tool's versatility, allowing maintenance teams to manage both routine and unplanned activities within a unified framework.



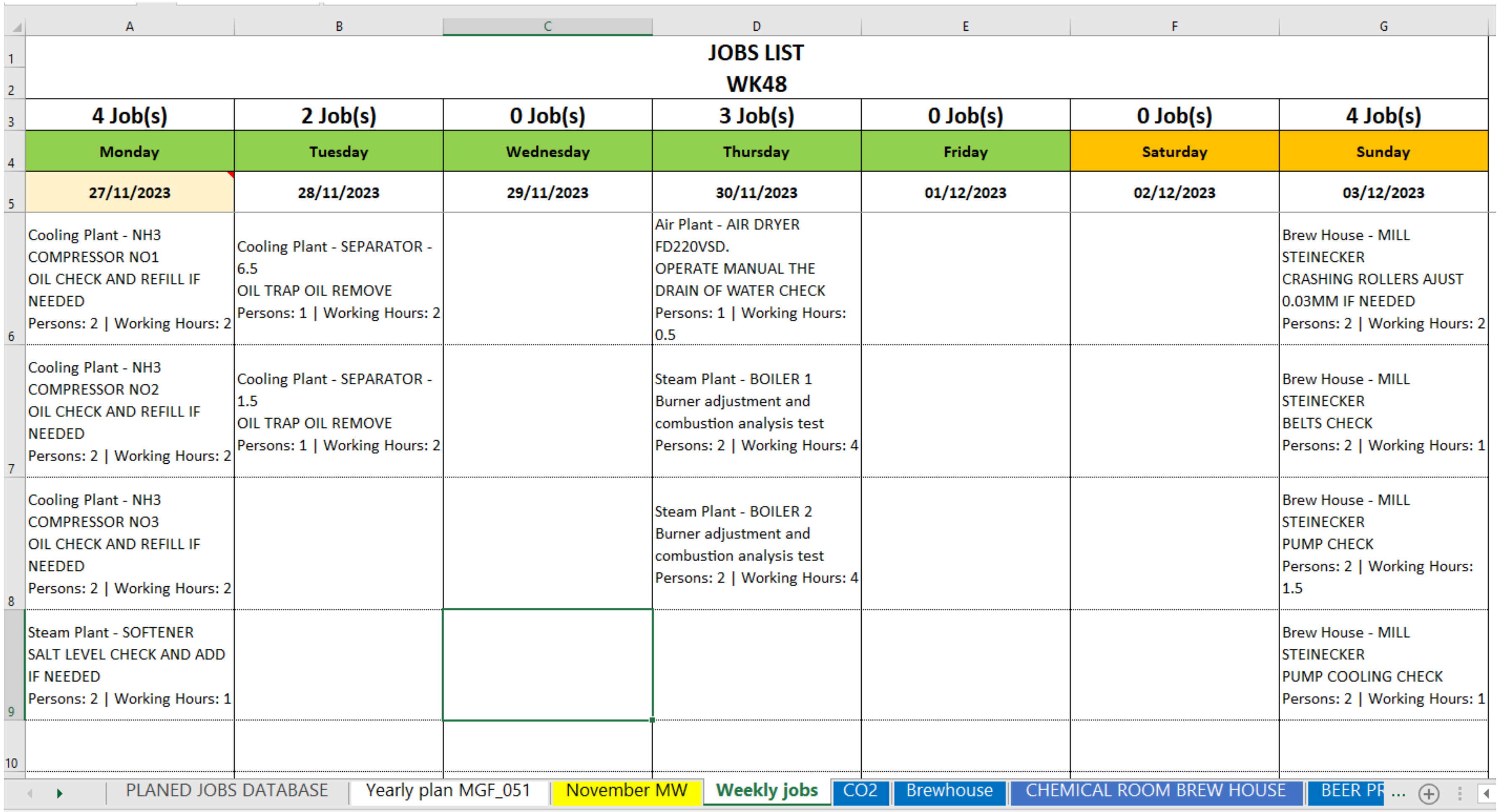
| | A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R | S | T | U | V | W | X | Y | Z | AA | AB | AC | AD | AE | AF | AG | AH | AI | AJ | AK | AL | AM | AN | AO | AP | AQ | AR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | MGF_051 | Annual Preventive Maintenance Schedule by Date | | | | | | January | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2 | AREA | EQUIPMENT | ACTIVITY | FREQUENCY | START DATE | PERSONS | WORKING HOURS | 01 January 2023 | 02 January 2023 | 03 January 2023 | 04 January 2023 | 05 January 2023 | 06 January 2023 | 07 January 2023 | 08 January 2023 | 09 January 2023 | 10 January 2023 | 11 January 2023 | 12 January 2023 | 13 January 2023 | 14 January 2023 | 15 January 2023 | 16 January 2023 | 17 January 2023 | 18 January 2023 | 19 January 2023 | 20 January 2023 | 21 January 2023 | 22 January 2023 | 23 January 2023 | 24 January 2023 | 25 January 2023 | 26 January 2023 | 27 January 2023 | 28 January 2023 | 29 January 2023 | 30 January 2023 | 31 January 2023 | 01 February 2023 | 02 February 2023 | 03 February 2023 | 04 February 2023 | 05 February 2023 | 06 February 2023 |
| 3 | | | | | | | | 52 | Week 01 | | | | | | | Week 02 | | | | | | | Week 03 | | | | | | | Week 04 | | | | | | | Week 05 | | | | | | | |
| 4 | | | | | | | | Sun | Mon | Tue | Wed | Thu | Fri | Sat | Sun | Mon | Tue | Wed | Thu | Fri | Sat | Sun | Mon | Tue | Wed | Thu | Fri | Sat | Sun | Mon | Tue | Wed | Thu | Fri | Sat | Sun | Mon | Tue | Wed | Thu | Fri | Sat | Sun | Mon |
| 38 | Brew House | COLD WATER TANK | VALVES CHECK | Quarterly | 09/03/2023 | 1 | 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 39 | Brew House | HOT WATER TANK | PUMP CHECK | Quarterly | 16/03/2023 | 2 | 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 40 | Brew House | HOT WATER TANK | VALVES CHECK | Quarterly | 16/03/2023 | 2 | 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 41 | Brew House | YEAST TANKS | SAMSON VALVES CHECK AND LUBRICATE THE DRY AREA | Quarterly | 26/05/2023 | 2 | 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 42 | Brew House | YEAST TANKS | CHECK AND CHANGE THE GASKETS IF NEEDED | Six-monthly | 26/05/2023 | 2 | 3 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 43 | Brew House | YEAST TANKS | MANIFOLTS VALVES CHECK | Six-monthly | 04/05/2023 | 2 | 3 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 44 | Brew House | YEAST TANKS | SOLENOID VALVES FOR | Six-monthly | 02/03/2023 | 2 | 4 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 45 | Brew House | CHEMICAL ROOM | ProMinent DOSING PUMP ACID CHECK | Quarterly | 18/01/2023 | 2 | 2 | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | |
| 46 | Brew House | CHEMICAL ROOM | ProMinent DOSING PUMP SODA | Quarterly | 18/01/2023 | 2 | 2 | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | |
| 47 | Beer Processing | GEA Westfalia Separator | OIL CHECK AND REFILL IF NEEDED | Monthly | 24/01/2023 | 1 | 1 | | | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | | |
| 48 | Beer Processing | GEA Westfalia Separator | SERVICE | Planned Job | 13/02/2023 | 2 | 16 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 49 | Cooling Plant | NH3 COMPRESSOR NO1 | OIL CHECK AND REFILL IF NEEDED | Weekly | 02/01/2023 | 2 | 2 | | X | | | | | | | X | | | | | | | X | | | | | | | X | | | | | | | X | | | | | | | X |
| 50 | Cooling Plant | NH3 COMPRESSOR NO2 | OIL CHECK AND REFILL IF NEEDED | Weekly | 02/01/2023 | 2 | 2 | | X | | | | | | | X | | | | | | | X | | | | | | | X | | | | | | | X | | | | | | | X |
| 51 | Cooling Plant | NH3 COMPRESSOR NO3 | OIL CHECK AND REFILL IF NEEDED | Weekly | 02/01/2023 | 2 | 2 | | X | | | | | | | X | | | | | | | X | | | | | | | X | | | | | | | X | | | | | | | X |
| 52 | Cooling Plant | NH3 COMPRESSOR NO1 | SOLENOID VALVES CHECK | Quarterly | 21/02/2023 | 2 | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 53 | Cooling Plant | NH3 COMPRESSOR NO2 | SOLENOID VALVES CHECK | Quarterly | 21/02/2023 | 2 | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 54 | Cooling Plant | NH3 COMPRESSOR NO3 | SOLENOID VALVES CHECK | Quarterly | 21/02/2023 | 2 | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 55 | Cooling Plant | NH3 COMPRESSOR NO1 | OIL CHANGE | Yearly | 14/03/2023 | 2 | 3 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 56 | Cooling Plant | NH3 COMPRESSOR NO2 | OIL CHANGE | Yearly | 14/11/2023 | 2 | 3 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 57 | Cooling Plant | NH3 COMPRESSOR NO3 | OIL CHANGE | Yearly | 14/04/2023 | 2 | 3 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 58 | Cooling Plant | NH3 COMPRESSOR NO1 | INDICATIONS CHECK dp 1.8-2.3BAR | Monthly | 04/01/2023 | 2 | 2 | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | X | | |
| 59 | Cooling Plant | NH3 COMPRESSOR NO2 | INDICATIONS CHECK dp 1.8-2.3BAR | Monthly | 04/01/2023 | 2 | 2 | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | X | | |
| | | | INDICATIONS | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

*Picture 28 Yearly plan view 1.*



|  | A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R | S | T | U | V | W | X | Y | Z | AA | AB | AC | AD | AE | AF | AG | AH | AI | AJ | AK | AL | AM | AN | AO | AP | AQ | AR | AS | AT | AU | AV |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | MGF_051 | Annual Preventive Maintenance Schedule by Date | | | | | | January | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 2 | AREA | EQUIPMENT | Refresh Dates<br>ACTIVITY | FREQUENCY | START DATE | PERSONS | WORKING HOURS | 01 January 2023 | 02 January 2023 | 03 January 2023 | 04 January 2023 | 05 January 2023 | 06 January 2023 | 07 January 2023 | 08 January 2023 | 09 January 2023 | 10 January 2023 | 11 January 2023 | 12 January 2023 | 13 January 2023 | 14 January 2023 | 15 January 2023 | 16 January 2023 | 17 January 2023 | 18 January 2023 | 19 January 2023 | 20 January 2023 | 21 January 2023 | 22 January 2023 | 23 January 2023 | 24 January 2023 | 25 January 2023 | 26 January 2023 | 27 January 2023 | 28 January 2023 | 29 January 2023 | 30 January 2023 | 31 January 2023 | 01 February 2023 | 02 February 2023 | 03 February 2023 | 04 February 2023 | 05 February 2023 | 06 February 2023 | 07 February 2023 | 08 February 2023 | 09 February 2023 | 10 February 2023 |
| 3 | | | | | | | | 52 | Week 01 | | | | | | | Week 02 | | | | | | | Week 03 | | | | | | | Week 04 | | | | | | | Week 05 | | | | | | | Week 06 | | | | |
| 4 | | | | | | | | Sun | Mon | Tue | Wed | Thu | Fri | Sat | Sun | Mon | Tue | Wed | Thu | Fri | Sat | Sun | Mon | Tue | Wed | Thu | Fri | Sat | Sun | Mon | Tue | Wed | Thu | Fri | Sat | Sun | Mon | Tue | Wed | Thu | Fri | Sat | Sun | Mon | Tue | Wed | Thu | Fr |
| 71 | Cooling Plant | SEPARATOR -6.5 | OIL TRAP OIL REMOVE | Weekly | 03/01/2023 | 1 | 2 | | | X | | | | | | | X | | | | | | | X | | | | | | | X | | | | | | | X | | | | | | | X | | | |
| 72 | Cooling Plant | SEPARATOR -1.5 | OIL TRAP OIL REMOVE | Weekly | 03/01/2023 | 1 | 2 | | | X | | | | | | | X | | | | | | | X | | | | | | | X | | | | | | | X | | | | | | | X | | | |
| 73 | Cooling Plant | GLYCOOL -6.5 | LEVEL CHECK AND REFILL IF NEEDED | Quarterly | 07/03/2023 | 2 | 3 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 74 | Cooling Plant | GLYCOOL -6.5 | GLYCOOL SAMPLE FOR | Six-monthly | 07/03/2023 | 1 | 0.5 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 75 | Cooling Plant | GLYCOOL CO2 | GLYCOOL SAMPLE FOR | Six-monthly | 07/03/2023 | 1 | 0.5 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 76 | Cooling Plant | GLYCOOL YEAST TANKS | GLYCOOL SAMPLE FOR | Six-monthly | 07/03/2023 | 1 | 0.5 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 77 | Air Plant | Atlas Copco oil free air compressor ZT75VSD-WP | RUNING HOURS CHECK | Monthly | 05/01/2023 | 1 | 0.5 | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | X | | | | | |
| 78 | Air Plant | COMPRESSOR 1 IR Ingersoll Rand IRN75K-OF 75kw | RUNING HOURS CHECK | Monthly | 05/01/2023 | 1 | 0.5 | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | X | | | | | |
| 79 | Air Plant | AIR DRYER FD220VSD. | RUNING HOURS CHECK | Monthly | 05/01/2023 | 1 | 0.5 | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | X | | | | | |
| 80 | Air Plant | AIR DRYER FD220VSD. | OPERATE MANUAL THE DRAIN OF WATER CHECK | Weekly | 05/01/2023 | 1 | 0.5 | | | | | X | | | | | | | X | | | | | | | X | | | | | | | X | | | | | | | X | | | | | | | X | |
| 81 | Steam Plant | BOILER 1 | MAIN SERVICE AND INSPECTION DRY AND WET | Planned Job | 20/02/2023 | 3 | 24 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 82 | Steam Plant | BOILER 2 | MAIN SERVICE AND INSPECTION DRY AND WET | Planned Job | 13/02/2023 | 3 | 24 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 83 | Steam Plant | BOILER 1 | TUMPA CLEANING | Monthly | 29/01/2023 | 1 | 4 | | | | | | | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | |
| 84 | Steam Plant | BOILER 2 | TUMPA CLEANING | Monthly | 05/02/2023 | 1 | 4 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | X | | | | | |
| 85 | Steam Plant | BOILER 1 | Burner adjustment and combustion analysis test | Monthly | 12/01/2023 | 2 | 4 | | | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 86 | Steam Plant | BOILER 2 | Burner adjustment and combustion analysis test | Monthly | 12/01/2023 | 2 | 4 | | | | | | | | | | | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| 87 | Steam Plant | BOILER CLEANING | CHECK THE OIL OF THE CLEANING MACHINE | Monthly | 02/01/2023 | 1 | 1 | | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | |
| 88 | Steam Plant | BOILER 1 | STRAINER LFO CLEANING | Monthly | 29/01/2023 | 1 | 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | X | | | | | | | | | | | | |
| 89 | Steam Plant | BOILER 2 | STRAINER LFO CLEANING | Monthly | 05/02/2023 | 1 | 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | X | | | | | |
| 90 | Steam Plant | LFO PUMPS | ROTATE THE LFO PUMPS | Six-monthly | 01/01/2023 | 2 | 1 | X | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |

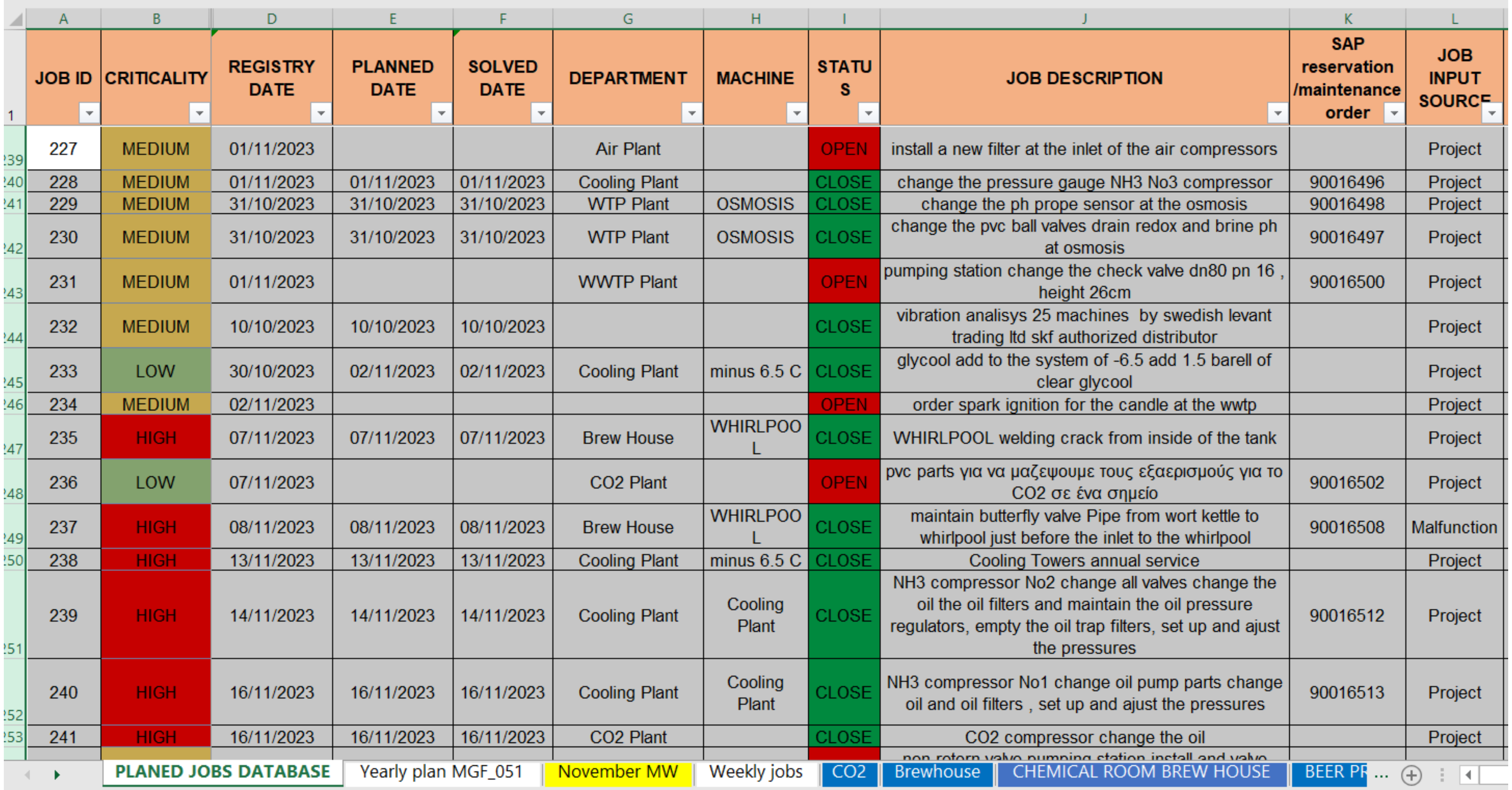
*Picture 29 Yearly Plan view 2*



JOBS LIST
WK48

| 4 Job(s) | 2 Job(s) | 0 Job(s) | 3 Job(s) | 0 Job(s) | 0 Job(s) | 4 Job(s) |
|---|---|---|---|---|---|---|
| Monday | Tuesday | Wednesday | Thursday | Friday | Saturday | Sunday |
| 27/11/2023 | 28/11/2023 | 29/11/2023 | 30/11/2023 | 01/12/2023 | 02/12/2023 | 03/12/2023 |
| Cooling Plant - NH3 COMPRESSOR NO1<br>OIL CHECK AND REFILL IF NEEDED<br>Persons: 2 \| Working Hours: 2 | Cooling Plant - SEPARATOR - 6.5<br>OIL TRAP OIL REMOVE<br>Persons: 1 \| Working Hours: 2 | | Air Plant - AIR DRYER FD220VSD.<br>OPERATE MANUAL THE DRAIN OF WATER CHECK<br>Persons: 1 \| Working Hours: 0.5 | | | Brew House - MILL STEINECKER<br>CRASHING ROLLERS AJUST 0.03MM IF NEEDED<br>Persons: 2 \| Working Hours: 2 |
| Cooling Plant - NH3 COMPRESSOR NO2<br>OIL CHECK AND REFILL IF NEEDED<br>Persons: 2 \| Working Hours: 2 | Cooling Plant - SEPARATOR - 1.5<br>OIL TRAP OIL REMOVE<br>Persons: 1 \| Working Hours: 2 | | Steam Plant - BOILER 1<br>Burner adjustment and combustion analysis test<br>Persons: 2 \| Working Hours: 4 | | | Brew House - MILL STEINECKER<br>BELTS CHECK<br>Persons: 2 \| Working Hours: 1 |
| Cooling Plant - NH3 COMPRESSOR NO3<br>OIL CHECK AND REFILL IF NEEDED<br>Persons: 2 \| Working Hours: 2 | | | Steam Plant - BOILER 2<br>Burner adjustment and combustion analysis test<br>Persons: 2 \| Working Hours: 4 | | | Brew House - MILL STEINECKER<br>PUMP CHECK<br>Persons: 2 \| Working Hours: 1.5 |
| Steam Plant - SOFTENER<br>SALT LEVEL CHECK AND ADD IF NEEDED<br>Persons: 2 \| Working Hours: 1 | | | | | | Brew House - MILL STEINECKER<br>PUMP COOLING CHECK<br>Persons: 2 \| Working Hours: 1 |

*Picture 30 Weekly Jobs view*



| JOB ID | CRITICALITY | REGISTRY DATE | PLANNED DATE | SOLVED DATE | DEPARTMENT | MACHINE | STATUS | JOB DESCRIPTION | SAP reservation /maintenance order | JOB INPUT SOURCE |
|---|---|---|---|---|---|---|---|---|---|---|
| 227 | MEDIUM | 01/11/2023 | | | Air Plant | | OPEN | install a new filter at the inlet of the air compressors | | Project |
| 228 | MEDIUM | 01/11/2023 | 01/11/2023 | 01/11/2023 | Cooling Plant | | CLOSE | change the pressure gauge NH3 No3 compressor | 90016496 | Project |
| 229 | MEDIUM | 31/10/2023 | 31/10/2023 | 31/10/2023 | WTP Plant | OSMOSIS | CLOSE | change the ph prope sensor at the osmosis | 90016498 | Project |
| 230 | MEDIUM | 31/10/2023 | 31/10/2023 | 31/10/2023 | WTP Plant | OSMOSIS | CLOSE | change the pvc ball valves drain redox and brine ph at osmosis | 90016497 | Project |
| 231 | MEDIUM | 01/11/2023 | | | WWTP Plant | | OPEN | pumping station change the check valve dn80 pn 16 , height 26cm | 90016500 | Project |
| 232 | MEDIUM | 10/10/2023 | 10/10/2023 | 10/10/2023 | | | CLOSE | vibration analisys 25 machines by swedish levant trading ltd skf authorized distributor | | Project |
| 233 | LOW | 30/10/2023 | 02/11/2023 | 02/11/2023 | Cooling Plant | minus 6.5 C | CLOSE | glycool add to the system of -6.5 add 1.5 barell of clear glycool | | Project |
| 234 | MEDIUM | 02/11/2023 | | | | | OPEN | order spark ignition for the candle at the wwtp | | Project |
| 235 | HIGH | 07/11/2023 | 07/11/2023 | 07/11/2023 | Brew House | WHIRLPOOL | CLOSE | WHIRLPOOL welding crack from inside of the tank | | Project |
| 236 | LOW | 07/11/2023 | | | CO2 Plant | | OPEN | pvc parts για να μαζεψουμε τους εξαερισμούς για το CO2 σε ένα σημείο | 90016502 | Project |
| 237 | HIGH | 08/11/2023 | 08/11/2023 | 08/11/2023 | Brew House | WHIRLPOOL | CLOSE | maintain butterfly valve Pipe from wort kettle to whirlpool just before the inlet to the whirlpool | 90016508 | Malfunction |
| 238 | HIGH | 13/11/2023 | 13/11/2023 | 13/11/2023 | Cooling Plant | minus 6.5 C | CLOSE | Cooling Towers annual service | | Project |
| 239 | HIGH | 14/11/2023 | 14/11/2023 | 14/11/2023 | Cooling Plant | Cooling Plant | CLOSE | NH3 compressor No2 change all valves change the oil the oil filters and maintain the oil pressure regulators, empty the oil trap filters, set up and ajust the pressures | 90016512 | Project |
| 240 | HIGH | 16/11/2023 | 16/11/2023 | 16/11/2023 | Cooling Plant | Cooling Plant | CLOSE | NH3 compressor No1 change oil pump parts change oil and oil filters , set up and ajust the pressures | 90016513 | Project |
| 241 | HIGH | 16/11/2023 | 16/11/2023 | 16/11/2023 | CO2 Plant | | CLOSE | CO2 compressor change the oil | | Project |

Picture 31 Planed Jobs Database view

## 5.7. Training Program:

The Training Program section outlines the methods employed to equip the existing workforce with the necessary skills for effective utilization of the Excel tool in optimizing maintenance processes. The objective is to ensure that participants receive targeted instruction aligned with their existing knowledge and expertise. The training program emphasizes the user-friendly nature of the Excel tool and addresses the incorporation of new machines into the maintenance framework.

**Methods:**

1. **Tailored Training Modules:** Tailored training modules will be developed based on the identified skill levels within the maintenance team. The training content will be designed to cater to varying levels of familiarity with the Excel tool, ensuring that participants receive targeted instruction aligned with their existing knowledge and expertise.
2. **Hands-on Workshops:** Hands-on workshops will be conducted to familiarize users with the Excel tool. These workshops provide practical, interactive sessions where participants can actively engage with the tool, entering data, generating reports, and simulating real-world scenarios. This hands-on approach accelerates the learning process and enhances user confidence.
3. **Continuous Learning Sessions:** Continuous learning sessions will be established to support ongoing training and provide assistance as users integrate the Excel tool into their daily workflows. These sessions can take the form of regular check-ins, virtual Q&A forums, or additional workshops for advanced features. The goal is to create a culture of continuous improvement and learning.

**Ease of Use:**

The training emphasizes that while precision and accuracy are crucial in using the Excel tool, the interface is designed to be user-friendly and intuitive. Any user, regardless of their technical proficiency, can effectively utilize the tool after training. The simplicity of data entry ensures that the right information is captured accurately. The Excel tool is structured to empower every user, transforming them into wielders of a powerful maintenance planning tool without requiring advanced technical skills.

**Incorporating New Machines:**

In the case of new machines, the training program addresses the process of entering specifications from the manual into the Excel tool. This includes adding information such as service frequencies, ensuring that the tool remains up-to-date and reflective of the evolving maintenance needs. The training program instills a proactive approach, empowering users to seamlessly integrate new equipment into the existing maintenance framework.

## 5.8. Evaluation and Adjustment:

The Evaluation and Adjustment phase is a critical component in ensuring the ongoing effectiveness of the Excel tool for preventive maintenance within the brewery. This phase aims to thoroughly assess the tool's performance, incorporating user feedback, system analytics, and key performance indicators. By conducting post-implementation reviews, the methodology seeks to identify areas of improvement, enabling a critical examination of the tool's functionality, user interaction, and overall impact on maintenance processes. The subsequent adjustments and enhancements are based on the insights gained from these evaluations, ensuring that the Excel tool remains aligned with evolving maintenance needs, user expectations, and technological advancements. This iterative process is essential for sustaining the tool's long-term effectiveness. The adaptability of the Excel tool is also highlighted, emphasizing its capacity to evolve alongside changing requirements in the brewery's maintenance practices.

**Methods:**

1. **Evaluate Tool Performance:** Tool performance will be evaluated through a comprehensive analysis, incorporating user feedback, system analytics, and key performance indicators. User experiences and perceptions, combined with quantitative metrics, provide a holistic view of how well the Excel tool aligns with the brewery's maintenance objectives.
2. **Post-Implementation Reviews:** Post-implementation reviews will identify areas of improvement. These reviews involve a critical examination of the tool's functionality, user interaction, and overall impact on maintenance processes. Insights gained from

these reviews are instrumental in pinpointing specific adjustments needed for optimal performance.

3. **Adjustments and Enhancements:** Based on the evaluation outcomes and post-implementation reviews, necessary adjustments will be made to the tool and training programs. Continuous refinement ensures that the Excel tool remains aligned with evolving maintenance needs, user expectations, and technological advancements. This iterative process is key to sustaining the tool's effectiveness over the long term.

**Conclusion:**

The methodology presented in this chapter serves as a comprehensive guide for understanding existing preventive maintenance practices in the brewery and facilitating the development and implementation of the Excel tool. Through systematic data gathering, analysis, and pilot implementations, the methodology establishes a robust foundation for optimizing maintenance processes. The ultimate goal is to achieve sustained improvements in operational efficiency within the brewery.

**Continuous Adaptation:**

It's crucial to highlight that with continuous use, the Excel tool allows for the flexibility to add or remove data and functions. This adaptability ensures that the tool remains a tailor-made solution, evolving in tandem with the brewery's changing requirements. As maintenance needs shift, new equipment is introduced, or operational strategies evolve, the Excel tool can be seamlessly adjusted to accommodate these changes. This dynamic nature underscores the tool's role as a custom-fit solution, continuously tailored to enhance efficiency and effectiveness in the brewery's maintenance practices.

# Chapter 6

# Results, Conclusions, and Suggestions

In this pivotal chapter, the outcomes of the brewery's preventive maintenance overhaul are thoroughly examined, encompassing a comprehensive needs assessment, an in-depth analysis of current practices, and strategic applications such as SWOT and reverse SWOT analyses. The chapter culminates by drawing meaningful conclusions from the implementation of an Excel-based preventive maintenance system, offering valuable insights and suggesting avenues for future improvements. This journey from reactive to proactive maintenance practices marks a significant milestone in the brewery's pursuit of operational excellence.

## Results:

### 1. Needs Assessment: Identification of Key Requirements and Challenges in Preventive Maintenance

The needs assessment phase played a pivotal role in uncovering essential insights into the existing state of preventive maintenance within the brewery. Employing a multifaceted approach involving interviews, focus group discussions, and surveys, this phase sought to identify key requirements and challenges. The following key findings emerged:

**User-Friendly System:** Through in-depth interviews with maintenance personnel at various levels and facilitated focus group discussions, it became evident that there was a significant desire for a user-friendly preventive maintenance system. The workforce emphasized the importance of a tool that could be easily navigated and understood by individuals with varying levels of technical expertise. This highlighted the need for a system that promotes broad accessibility and encourages active engagement from all team members.

**Standardized Plans and Documentation:** The needs assessment underscored a crucial requirement for standardized preventive maintenance plans and improved documentation practices. Interviews with maintenance staff revealed a prevailing lack of consistency and standardization in the existing maintenance procedures. The absence of standardized plans posed challenges in terms of efficiency, resource allocation, and knowledge transfer.

**Challenges in Current Practices:** Focus group discussions and surveys provided a platform for maintenance personnel to articulate the challenges they faced in the current preventive maintenance landscape. The predominant theme that emerged was the reactive nature of the maintenance culture, where responses were largely triggered by equipment breakdowns rather than pre-scheduled preventive measures. This reactive approach was identified as a major obstacle to operational efficiency, highlighting the need for a strategic shift towards proactive maintenance strategies.

**Importance of Standardization:** During the needs assessment, the significance of standardization in preventive maintenance practices was emphasized. The lack of standardized plans and documentation was identified as a source of inefficiency and a barrier to effective collaboration. Standardization was perceived as a fundamental step toward establishing a cohesive and organized maintenance framework, enabling the workforce to operate with a shared set of guidelines and practices.

In conclusion, the needs assessment phase not only unveiled the existing challenges in the preventive maintenance practices of the brewery but also outlined the fundamental requirements for a successful transformation. The emphasis on user-friendliness, standardization, and the shift from reactive to proactive strategies laid the groundwork for subsequent phases, guiding the development of an optimized preventive maintenance system tailored to the unique needs of the brewery in Cyprus.

### 2. Current State Analysis: Examination of Existing Practices

The current state analysis delved into the historical context of preventive maintenance within the brewery, employing a multi-faceted approach to comprehensively understand the existing practices:

**Examination of Historical Maintenance Records:** In-depth scrutiny of historical maintenance records provided valuable insights into past practices, revealing a reliance on reactive maintenance measures. The analysis of breakdown reports offered a clear picture of the prevalent culture, emphasizing the need for a shift towards a more proactive and systematic approach.

**On-Site Observations:** On-site observations were conducted to witness firsthand the execution of preventive maintenance tasks. This revealed a predominantly reactive maintenance culture, characterized by interventions primarily triggered by unexpected breakdowns. The findings underscored the importance of transitioning towards planned and proactive maintenance strategies for enhanced operational efficiency.

**Revealed Predominantly Reactive Culture:** The analysis brought to light a prevailing reactive maintenance culture within the brewery. Maintenance activities were primarily initiated in response to equipment failures rather than being systematically scheduled. This reactive approach contributed to increased downtime and hindered the overall effectiveness of maintenance efforts.

**Lack of Standardized Plans:** The examination highlighted a lack of standardized preventive maintenance plans across various equipment categories. This absence of uniformity resulted in inefficiencies and challenges in resource allocation. The need for standardized plans emerged as a critical aspect for streamlining maintenance practices and optimizing resource utilization.

**Overreliance on Experienced Personnel:** The current state analysis revealed a notable overreliance on experienced personnel for decision-making in maintenance activities. While experience is valuable, the lack of standardized plans and documentation meant that crucial knowledge was often held by a few individuals. This highlighted the necessity of a more structured system that captures and disseminates expertise across the entire maintenance team.

### 3. SWOT Analysis: Evaluation of Internal and External Factors

The SWOT analysis provided a comprehensive evaluation of internal strengths, weaknesses, and external opportunities and threats within the brewery's maintenance practices:

**Strengths in Experienced Personnel:** The analysis identified experienced personnel as a significant internal strength. The wealth of knowledge and expertise held by these individuals presented an asset that could be strategically leveraged for the improvement of preventive maintenance practices.

**Opportunities in Technological Advancements:** External opportunities were recognized in the form of advancements in technology. The integration of technological tools and solutions offered the potential to enhance the efficiency and effectiveness of preventive maintenance processes.

**Weaknesses in Documentation:** Internal weaknesses were acknowledged in the realm of documentation. Incomplete or inadequate documentation posed challenges in knowledge transfer and continuity, emphasizing the need for improved record-keeping practices.

**Threats from Equipment Variability:** External threats were identified in the variability of equipment within the brewery. The diverse range of machinery presented challenges in standardizing maintenance plans, creating a potential threat to streamlined maintenance practices.

### 4. Reverse SWOT Analysis: Strategies for Improvement

The reverse SWOT analysis focused on converting identified weaknesses into strengths and threats into opportunities:

**Proactive Training Strategies:** Strategies were devised to convert weaknesses in documentation into strengths. Proactive training programs were proposed to systematically transfer knowledge and expertise across the maintenance team, reducing dependence on a few experienced individuals.

**Enhancement of Documentation Practices:** Recognizing documentation weaknesses, the reverse SWOT analysis emphasized the enhancement of documentation practices. This involved the development of standardized templates, procedures, and guidelines for consistent and thorough record-keeping.

**Leveraging Existing Expertise:** To convert the threat from equipment variability into an opportunity, the strategy involved leveraging existing expertise. The diverse knowledge held by experienced personnel could be systematically incorporated into standardized plans, addressing the challenge posed by equipment variability.

### 5. Data Collection for Excel Tool Development: Comprehensive Gathering of Information

The data collection phase was dedicated to gathering essential information for the development of the Excel tool:

**Creation of Equipment Inventory:** A comprehensive inventory of all equipment and critical components was created. This involved cataloging specifications, manuals, and critical components to establish a foundational database for the Excel tool.

**Extraction from Existing Plans and Records:** Information was systematically extracted from existing maintenance plans, manuals, and historical records. This process aimed to consolidate relevant data for inclusion in the Excel tool, ensuring accuracy and completeness.

**User Preferences and Expectations:** Surveys were conducted to gather insights into user preferences and expectations regarding the functionalities and features of the Excel tool. This user-centric approach aimed to tailor the tool to the specific needs and preferences of the maintenance team.

### 6. Pilot Implementation: Implementation of the Excel Tool in a Controlled Environment

The pilot implementation phase involved introducing the Excel tool on a small scale with a select group of maintenance personnel:

**Usability Evaluation:** The Excel tool was evaluated for usability, with a focus on how well it aligned with the day-to-day tasks of maintenance personnel. Feedback was actively sought to identify areas of improvement and refinement.

**Functionality Assessment:** The functionality of the Excel tool was assessed in terms of its ability to automate scheduling, provide alerts, and facilitate standardized plan creation. The aim was to ensure that the tool effectively addressed the identified challenges in preventive maintenance.

**Feedback Collection:** Feedback was systematically collected from the pilot group, encompassing their experiences with the tool, suggestions for improvement, and observations on its effectiveness. This feedback formed a crucial basis for refining the tool in preparation for broader implementation.

**Identification of Areas for Improvement:** The pilot implementation phase identified specific areas for improvement, including adjustments to user interfaces, enhancements in automation algorithms, and modifications based on user preferences. These insights were instrumental in refining the tool for optimal performance.

### 7. Training Program: Development and Implementation of Training Modules

The training program aimed to equip the existing workforce with the skills necessary for effective use of the Excel tool:

**Tailored Training Modules:** Training modules were developed based on the skill levels identified within the workforce. These modules were designed to cater to the diverse needs of individuals with varying levels of technical expertise.

**Hands-On Workshops:** Practical, hands-on workshops were conducted to actively engage maintenance personnel with the Excel tool. These sessions provided an opportunity for users to familiarize themselves with the tool's functionalities in a controlled and supportive environment.

**Continuous Learning Sessions:** Continuous learning sessions were established to facilitate ongoing skill development and knowledge transfer. These sessions ensured that users remained adept at utilizing the Excel tool as they encountered various scenarios in their day-to-day responsibilities.

**User Support Systems:** Support systems, such as helpdesk services and online resources, were established to address questions and challenges faced by users during the initial stages of implementation. These support mechanisms aimed to enhance user confidence and foster a positive attitude towards the new system.

# Conclusions:

The implementation of the Excel tool has fundamentally transformed our preventive maintenance practices at the brewery. The shift from a reactive to a proactive maintenance culture is now evident, thanks to the automated scheduling and alerts system provided by the Excel tool. This transition allows us to anticipate and address maintenance needs before they escalate.

The centralized nature of the tool has significantly improved collaboration among team members. Challenges in documentation and knowledge transfer have been effectively addressed, resulting in a more streamlined and efficient maintenance process.

Resource allocation has been optimized through the integration of analytics and reporting features in the Excel tool. This spans manpower, time, and spare parts, ultimately enhancing our overall operational efficiency.

The tailored training program has played a crucial role in ensuring the user-friendly adoption of the Excel tool. Overcoming potential resistance to change, it has fostered a positive attitude among the workforce toward the new system, ensuring its effective utilization.

The strategies derived from the SWOT and reverse SWOT analyses have proven effective in converting weaknesses into strengths and threats into opportunities. This strategic alignment has been crucial in guiding the successful implementation of the Excel tool.

Looking ahead, continuous training and support mechanisms are essential to ensuring that users consistently remain adept at utilizing the Excel tool. Integrating advanced technologies, such as IoT sensors and predictive analytics, holds the potential to further elevate the tool's capabilities for proactive maintenance.

Regular audits of the Excel tool's performance, user satisfaction, and overall impact on preventive maintenance are crucial. Utilizing feedback from these audits will guide continuous improvement efforts, ensuring the tool remains aligned with evolving needs.

Exploring the expansion of the Excel tool's use to other departments, such as production and quality control, presents an opportunity for holistic operational optimization. This cross-functional integration can maximize the tool's impact.

Establishing collaborative relationships with equipment manufacturers is crucial to ensure that the Excel tool remains abreast of the latest industry standards and recommendations. This ongoing collaboration reinforces the tool's relevance and effectiveness.

The implementation of the Excel tool has revolutionized our approach to preventive maintenance at the brewery, offering comprehensive insights into the year's crucial maintenance tasks and required services right from the outset. This foresight enables us to strategically plan our operations, considering factors such as manpower, seasonal variations, and budget constraints. The Excel tool's predictive capabilities extend to forecasting annual costs for necessary spare parts, allowing us to proactively propose jobs based on machine availability. Notably, the introduction of biannual maintenance weeks, during which the entire factory undergoes extensive servicing, has become a pivotal operational strategy.

The tool also serves as a valuable resource for new engineers, facilitating easy comprehension and aiding in job program planning to ensure no crucial tasks are overlooked. The centralized e-database for machine manuals, accessible on tablets, has streamlined information retrieval, saving considerable time compared to traditional hard copy searches. Furthermore, the tool's record-keeping functionality enhances our ability to identify anomalies and recurring malfunctions, providing a powerful foundation for Root Cause Failure Analysis (RCFA) and deployment teams. While continuous updates and detailed additions to the database are essential, the Excel tool has undeniably elevated our maintenance practices to new levels of efficiency and effectiveness.

In conclusion, the implementation of the Excel tool marks a significant milestone in preventive maintenance within the brewery in Cyprus. The transition from reactive to proactive practices, coupled with improvements in collaboration, documentation, and resource allocation, signifies a strategic move towards operational optimization. Notably, the tool's success in the pilot phase and the training program highlights its user-friendly adoption and potential for sustained effectiveness. As the brewery evolves, the suggestions for future improvements provide a roadmap for continuous enhancements, solidifying the Excel tool as a dynamic asset in the pursuit of operational excellence.

# Suggestions:

To further enhance the Excel tool and elevate its technological capabilities, several suggestions can be considered. First, incorporating advanced Visual Basic codes can elevate the tool's functionality, providing a more sophisticated and user-friendly interface with intuitive buttons and an aesthetically pleasing layout.

Additionally, integrating warehouse data into the tool, specifically detailing available spare parts, would ensure real-time updates on inventory. This feature not only keeps the team informed about part availability but also generates reports for cost analysis, contributing to more informed decision-making.

Exploring the development of a mobile application is another valuable suggestion. This app could streamline the feedback process, allowing mechanics to provide instant updates on job completion through their mobile devices. The application might even enable mechanics to upload images for documentation purposes, enhancing the record-keeping process.Moreover, introducing a dedicated tab featuring statistics and graphs could offer a visual representation of trends and peaks in maintenance activities. This analytical component can provide valuable insights into the performance of the maintenance processes over time, facilitating strategic decision-making and continuous improvement efforts.

In conclusion, these suggestions aim to take the Excel tool to the next level, incorporating cutting-edge features that not only improve functionality but also provide a more dynamic and efficient user experience for the maintenance team.

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