Ministry of Higher Education and Scientific Research
The School of Higher Commercial Studies

A thesis submitted in partial fulfillment of the requirements for the Master's degree in Business Sciences

Area: Distribution and Supply Chain Management

Topic:

The impact of efficient waste management on corporate profitability

Case Study: Natri Toothpaste by SAIDAL, Dar El Beida

Presented by:
Rim Amani BOUKEHILI

Supervised by :
Kamel MERARDA

11th Promotion

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Abstract:

Nowadays, the pharmaceutical industry plays a vital role in the national economy, focusing on research, development, manufacturing, and marketing. Efficient waste management within this industry is crucial for environmental sustainability and enhancing corporate profitability. This thesis explores the impact of efficient waste management on the profitability of SAIDAL, specifically at its Dar El Beida site.

Prompted by significant waste in NATRI toothpaste production, particularly during the COVID-19 pandemic when import restrictions halted production for eight months, the research aims to identify waste reduction areas that positively impact profit. The investigation includes a theoretical framework on waste management concepts, a case study of SAIDAL's operations, and data analysis from fieldwork, interviews, and waste records.

The study confirms that improving operator training, maintaining machinery, and implementing robust waste management strategies are essential for reducing waste and enhancing profitability. This research demonstrates that efficient waste management can significantly boost the profitability of pharmaceutical companies like SAIDAL. Recommendations aim to optimize production processes, reduce waste, and improve the company's financial performance, ensuring a more sustainable and profitable operation.

Key words: Pharmaceutical industry, Waste management, Profitability, SAIDAL, Sustainability.

ملخص

في الوقت الحاضر، تلعب الصناعة الدوائية دوراً أساسياً في الاقتصاد الوطني، حيث تركز على البحث والتطوير وتصنيع وتسويق المنتجات. إدارة النفايات بشكل فعال في هذه الصناعة ضرورية لتحقيق الاستدامة البيئية وتحسين ربحية الشركات. تستكشف هذه الأطروحة تأثير إدارة النفايات الفعالة على ربحية شركة صيدال، تحديداً في موقع دار البيضاء.

في مواجهة كمية كبيرة من النفايات في إنتاج معجون الأسنان ناتري، خاصة خلال جائحة الكوفيد 19 عندما توقفت الإنتاج لمدة ثمانية أشهر بسبب قيود الاستيراد، تهدف هذه الدراسة إلى تحديد المجالات التي يمكن أن تقلل من النفايات وتزيد من الأرباح. تشمل التحقيقات إطارًا نظريًا لمفاهيم إدارة النفايات، دراسة حالة لعمليات صيدال، وتحليل البيانات المستمدة من الأعمال الميدانية، والمقابلات، وسجلات النفايات.

تؤكد الدراسة أن تحسين تدريب المشغلين، وصيانة الآلات، وتنفيذ استراتيجيات قوية لإدارة النفايات أمر ضروري لتقليل النفايات وتحسين الربحية. تظهر هذه الدراسة أن الإدارة الفعالة للنفايات يمكن أن تزيد بشكل كبير من ربحية الشركات الدوائية مثل صيدال .التوصيات تهدف إلى تحسين عمليات الإنتاج، تقليل النفايات، وتحسين الأداء المالي للشركة، مما يضمن عملية أكثر استدامة وربحية.

الكلمات المفتاحية: صناعة الأدوية, ادارة النفايات, الربحية, صيدال, الاستدامة.

Résumé:

De nos jours, l'industrie pharmaceutique joue un rôle essentiel dans l'économie nationale, se concentrant sur la recherche, le développement, la fabrication et la commercialisation de produits. Une gestion efficace des déchets dans cette industrie est cruciale pour la durabilité environnementale et l'amélioration de la rentabilité des entreprises. Cette thèse explore l'impact de la gestion efficace des déchets sur la rentabilité de SAIDAL, spécifiquement sur le site de Dar El Beida.

Face à une quantité significative de déchets dans la production du dentifrice NATRI, en particulier pendant la pandémie de COVID-19 lorsque les restrictions à l'importation ont interrompu la production pendant huit mois, la recherche vise à identifier les domaines de réduction des déchets qui ont un impact positif sur les profits. L'investigation inclut un cadre théorique sur les concepts de gestion des déchets, une étude de cas des opérations de SAIDAL, et une analyse des données issues des travaux sur le terrain, des entretiens et des relevés de déchets.

L'étude confirme que l'amélioration de la formation des opérateurs, l'entretien des machines et la mise en œuvre de stratégies robustes de gestion des déchets sont essentiels pour réduire les déchets et améliorer la rentabilité. Cette recherche démontre que la gestion efficace des déchets peut significativement augmenter la rentabilité des entreprises pharmaceutiques comme SAIDAL. Les recommandations visent à optimiser les processus de production, réduire les déchets et améliorer la performance financière de l'entreprise, assurant une opération plus durable et rentable.

Les mots clés : Industrie pharmaceutique, Gestion des déchets, Rentabilité, SAIDAL, Durabilité.

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Abbreviations list

ACDIMA: Arab Company for Drug Industries and Medical Appliances.

API: Active Pharmaceutical Ingredient.

API: Active Pharmaceutical Ingredients.

CCWTTs: Combined Traditional Drinking Water Treatment Methods.

CFR: Code of Federal Regulations.

CRD: Research and Development Center.

EPD: The Environmental Protection Department.

FCA: Full Cost Accounting.

HDPE: High-Density Polyethylene.

HSRC: Human Sciences Research Council.

IWM: Integrated Waste Management**.**

Ksh: Kenyan shilling.

LDPE: Low-Density Polyethylene.

LFG: LandFill Gas.

MPAC: Matière Première Article de Conditionnement.

MSW: Municipal Solid Waste.

NEMA: The National Environment Management Authority.

PET: Polyethylene Terephthalate.

PP: Polypropylene.

PPB: Parts Per Billion.

PPB: The Pharmacy and Poisons Board.

PS: Polystyrene or Styrofoam.

PSM:PFIZER SAIDAL MANUFACTURING.

PSS: Product-Service Systems.

PVC: Polyvinyl Chloride.

SNM:SAIDAL North Africa Holding Manufacturing.

SOPs: Standard Operating Procedures.

SPA: Société par Actions/ Limited Liability Company by Shares.

TAPHCO: Tassili Pharmaceutical Company.

U.S: United States.

UCC: Unité ComerCiale.

UNEP: United Nations Environment Programme.

WHO: The World Health Organization.

WPS:WINTHROP PHARMA SAIDAL.

WTE: Waste To Energy.

WTO: World Trade Organization.

WWTPs: WasteWater Treatment Plants.

Summary

General introduction

In recent years, the issue of waste management has become increasingly important for businesses striving to balance sustainability with profitability. This is especially true for SAIDAL DAR EL BAIDA, a prominent pharmaceutical company known for its NATRI toothpaste production. The significant amount of waste generated by this product prompted this research, aimed at reducing waste and improving waste management practices within SAIDAL, particularly in the wake of the COVID-19 pandemic. The pandemic severely disrupted the company's operations, causing an eight-month production halt due to the unavailability of imported tubes, as international trade was restricted.

The central theme of this thesis is "The impact of efficient waste management on corporate profitability." Efficient waste management is crucial not only for environmental sustainability but also for enhancing the financial performance of a company. This research seeks to explore and identify which areas of waste reduction can positively impact SAIDAL's profitability.

The core problematic addressed in this thesis is: "Which waste reduction areas have a positive impact on profit?" This overarching question is dissected into several sub-questions to guide the research:

1. What are the concepts of "Waste Management"?
2. What are the interfering factors of the firm's waste?
3. How can the production process be improved to decrease waste?
4. How can the production process be improved to increase profit?

To address these questions, the research is built upon four main hypotheses:

1. Metal suppliers provide higher quality materials as a result of rigorous contracts.
2. Machine adjustments in the conveyor ensure the integrity of the product's packaging.
3. High-skilled workers handle sensitive products with care.
4. Final waste is recycled instead of being incinerated.

To verify these hypotheses, a descriptive and analytical methodology was adopted, based on a quantitative survey. The descriptive method is found in the three chapters of this thesis, through bibliographic research in the fields of logistics and marketing, in order to develop the theoretical dimension of this study.

In the first chapter, the theoretical part, I discussed different concepts of waste management, explaining the different types of waste and specifically pharmaceutical waste. In the second chapter, I discussed SAIDAL in general and SAIDAL DAR EL BAIDA specifically, including its subsidiaries, and more specifically the sub-department of stock management where I did my internship. In the final chapter, I studied and analyzed the results of my research to examine my various hypotheses and address my core research question.

This study employs both qualitative and quantitative research methods, including extensive fieldwork at SAIDAL's production unit, analysis of waste records, and interviews with various employees. The aim is to provide a comprehensive understanding of waste management practices at SAIDAL and offer practical recommendations to enhance their efficiency and profitability. Through this research, it is hoped that SAIDAL can adopt more sustainable production practices that not only reduce waste but also contribute to the company's bottom line.

Chapter 1: Key concepts of waste management

Since the way of handling waste impacts the profit of a company either it is positive or negative, then waste management is important as making profit, so having a good command on this is a tip to maximize gain.

In this chapter, I am going to start with making the concept keys of waste management clear including definitions and types, then I will explain how that waste is impacting environment, health and a company's profit.

The last section is for methods and techniques of waste management and how they perform in each situation.

Section 1: What is waste ?

This section is to explore the concept of waste, exploring its definition and delving into the diverse categories it encompasses. By unpacking these classifications, we gain a deeper appreciation for the multifaceted nature of waste and its impact on our environment.

1. Definition of waste:

Governmental bodies defined waste with different definitions depending on the context, Under its Waste Framework Directive, the European Union defines waste as an object that the holder discards, intends to discard or is required to discard .However for the United Nations (UNEP, 2009), waste refers to materials that are not prime products meant for consumption or further use.[1]

Waste presents a possible valuable resource, but safety precautions are essential as it can be dangerous sometimes.[2]

2. Definition of a solid waste:[3]

Solid waste can be broadly defined as solid materials that are currently considered more economical to discard than to utilize.

Volume 40 of the U.S. Code of Federation Regulations (40 CFR 240.101) defines a solid waste as:

Garbage, refuse, sludges, and other discarded solid materials resulting from industrial and commercial operations and from community activities. It does not include solids or dissolved material in domestic sewage or other significant pollutants in water resources, such as silt, dissolved or suspended solids in industrial wastewater effluents, dissolved materials in irrigation return flows or other common water pollutants.

3. Categories of wastes:[3]

By classifying waste, we can build cost-efficient solutions that prioritize both public health and environmental well-being, as we have:

1. Municipal
2. Hazardous

[1] **Kien, HEDWIG, A Gender Perspective of Municipal Solid Waste Generation and Management in the City of Bamenda, Cameroon**, Langaa RPCIG, 2018,page 19
[2] **Ranjit Singh BAXI** (BAXI, , Recycling our Future A Global Strategy, 2014), Whittles Publishing,2014,page 31
[3] **John PICHTEL,** (PICHTEL, 2014)**,** CRC Press, Second Edition,2014,page 6

3. Industrial
4. Medic (HEDWIG, 2018)
5. Universal
6. Construction and demolition
7. Radioactive
8. Mining
9. Agricultural

3.1.Municipal Solid Waste :

The term "Municipal Solid Waste," or MSW for short, refers to the various types of waste generated within a community. This waste originates from multiple sources, extending beyond what individual households throw away. In addition to residences, MSW encompasses waste produced by businesses, institutions, industries, and even municipal operations themselves.

Table 01 : Municipal Solid Waste Generation as a Function of Source

Type of waste	Its source
Domestic : (single- and multi-family homes)	Food scraps, food packaging, cans, bottles, newspapers, clothing, yard waste, old appliances
Commercial: (office buildings, retail companies, restaurants)	Office paper, corrugated boxes, food wastes, disposable tableware, paper napkins, yard waste, wood pallets
Institutional : (schools, hospitals, prisons)	Office paper, corrugated boxes, cafeteria waste, restroom wastes, classroom wastes, yard waste
Industrial : (packaging and administrative; not process wastes)	Office paper, corrugated boxes, wood pallets, cafeteria wastes
Municipal	Litter, street sweepings, abandoned automobiles, some construction and demolition debris

Source : Adapted from Franklin Associates, EPA530-R-98-010, 1999.

Highly heterogeneous is the right word for this category of waste , it encompasses durable goods (e.g; furniture), nondurable goods(e.g: textiles), packaging and containers, food wastes, yard wastes, and miscellaneous inorganic wastes.

It is broadly categorized into two groups: food scraps and other waste. Food scraps, which come from preparing and eating our meals, are mostly organic matter from plants and animals. This type of waste breaks down quickly by tiny organisms, often causing unpleasant smells and potentially harmful gases. Everything else in the trash, like packaging, paper, and yard

trimmings, is considered "other waste" and doesn't decompose as quickly. While some of this "other waste" can be burned for energy, not all of it is suitable for burning.

3.2.Hazardous Waste :

Most or all the sources mentioned in the previous table produce hazardous waste. Yet businesses and organizations that produce more than a certain amount of waste each month are subject to federal and state regulations, and the waste itself must also comply with these regulations.

RCRA defines hazardous waste as (40 CFR 240.101):

"Any waste or combination of wastes which pose a substantial present or potential hazard to human health or living organisms because such wastes are non-degradable or persistent in nature or because they can be biologically magnified, or because they can be lethal, or because they may otherwise cause or tend to cause detrimental cumulative effects."

According to RCRA we consider a dangerous waste if it corresponds to these characteristics:

- Ignitability.
- Corrosivity.
- Reactivity.
- Toxicity.

Hazardous waste comes from things like making solvents, coating metals, treating wood, and refining oil. Because it's dangerous, it needs stricter rules than regular trash (MSW). Every step of its journey must be carefully tracked – how it's made, stored, treated, moved, and finally disposed of. Businesses that make hazardous waste, along with those who move it and get rid of it, must follow strict regulations. This "start to finish" approach is crucial for handling hazardous waste responsibly.

3.3.Industrial Waste :

Some types of industrial waste, while not all harmful, are produced in large quantities by individual companies. Examples include leftover materials from burning coal, such as ash and sludge. Industries like paper, steel, and chemicals frequently generate large amounts of this type of waste.

Industrial waste isn't automatically labeled as regular trash or dangerous (hazardous). Labs test the waste to figure out if it's hazardous. If so, it has to be handled with extra care and

sent to a special facility. Waste that isn't dangerous can go to landfills, be spread on company land, or burned. A lot of industrial waste is wastewater, which is often stored or treated in special ponds.

3.4.Medical Waste :

Medical waste comes from various healthcare sources, including hospitals, doctors' offices, dentists, vets, nursing homes, clinics, labs, blood banks, and even funeral homes. While not all the waste from these places is infectious, hospitals generate the most regulated medical waste. Many healthcare facilities choose to treat most or all of their medical waste as potentially infectious, even though not everything they discard actually carries that risk. This is because it's often safer to be cautious and follow stricter guidelines for handling medical waste.

Regulated medical waste falls into several categories:

- Infectious materials: This includes things like cultures and leftover materials from labs, both medical and research-oriented.
- Body tissues and fluids: This includes removed tissues, organs, body parts, and fluids.
- Blood and blood products: This includes thrown-away blood and blood-related materials.
- Sharps: This includes both used and unused needles, syringes, and other sharp objects used in medical settings.
- Animal waste: This includes carcasses, body parts, and bedding of animals exposed to infections.
- Isolation waste: This refers to waste generated from treating patients with infectious diseases.

3.5.Universal Waste :

Universal wastes are specific types of hazardous waste that are managed under a simplified regulatory system compared to traditional hazardous waste. This streamlined system encourages the proper collection, transportation, and treatment of commonly generated hazardous wastes, such as batteries, pesticides, mercury-containing devices, and lamps.[4]

These include:

- Batteries: Like the ones found in electronics, cell phones, and laptops.
- Pesticides: Old, banned, or recalled pesticides that shouldn't be thrown in regular trash.

[4] https://floridadep.gov/waste/permitting-compliance-assistance/content/universal-wastes , consulted on 26/02/2024, at 18:05

- Thermostats: Those old-fashioned thermostats that contain liquid mercury.
- Light bulbs: Especially ones containing mercury or lead.

3.6.Construction and Demolition Debris:

Waste generated during construction, renovation, or demolition of structures like houses, buildings, roads, and bridges is called construction and demolition debris (C&D debris). This debris includes materials such as concrete, asphalt, wood, metals, drywall, and roofing.

3.7.Radioactive Waste:

Among industrial waste, a specific category exists called radioactive waste. This waste mainly comes from nuclear power plants, reprocessing facilities, and weapons sites. Additionally, research and medical procedures, including those using pharmaceuticals, generate some radioactive waste. A major concern surrounding radioactive materials, including waste, is their ability to cause effects at a distance.

3.8.Mining Waste:

Mine waste encompasses the soil or overburden rock that arises during the extraction of a desired resource, such as coal or precious metals, from beneath the surface of the Earth. This category also encompasses tailings or spoils generated during the processing of minerals, including the process of smelting. Furthermore, heap leaching, which involves using solutions like acid or cyanide to extract precious metals such as gold, silver, or copper from piles of low-grade waste rock or tailings, also generates mine waste.

3.9.Agricultural Waste:

Animal manure and crop residues contribute the majority of agricultural waste, with additional sources like pesticide containers and packaging also present.

On smaller farms, animal and plant waste is often directly recycled by spreading it on the soil. This practice, when done on-site, is an affordable way to add nutrients to the soil. However, managing waste from large animal concentrations becomes difficult, as seen in livestock feedlots and poultry farms. The large volume of manure, mostly consisting of water and diluted nutrients, raises concerns about cost and feasibility of off-site disposal. Additional challenges like odor, pathogens, salt content, and ammonia production emerge. In such situations, advanced techniques like anaerobic digestion or composting might be necessary to reduce waste

volume and potential toxicity. This not only makes transportation more cost-effective but also ensures proper hygiene.

Section 2: The impact of waste

In this section I'll be presenting the different impacts of different waste forms.

1. Classification of waste [5] :

Waste manifests in diverse forms, each with its unique characteristics. Its characterization can be articulated through various parameters. Common attributes utilized for waste classification encompass physical states, physical properties, potential for reuse, biodegradability, production source, and environmental impact degree (Demirbas, 2011; Dixon & Jones, 2005; White et al., 1995). White et al. (1995) propose a broad classification of waste into three main types based on physical states: liquid, solid, and gaseous waste. However, numerous classifications exist across different countries. Presented below are the most commonly employed classifications.

- Source :

Household/Domestic waste.

Industrial waste.

Agricultural waste.

Commercial waste.

Demolition and construction waste

Mining waste.

- Environmental impact:

Hazardous waste.

Non-hazardous waste.

- Physical state :

Solid waste.

Liquid waste.

Gaseous waste.

[5] EBIKAPADE Amasuomo & BAIRD Jim; (Amuasomo & Jim, 2016); Published by Canadian Center of Science and Education, School of Engineering and Built Environment, Glasgow Caledonian University, Glasgow, UK ; No. 4 ; Vol. 6; November 25, 2016; Page "88-96" ; Page 89

2. The impact of waste on the environment :

The textile industry releases significant volumes of pollutants, including liquid discharge, solid waste, and air emissions, into the environment. Traditionally recognized for high water usage, its primary environmental concern is the discharge of effluent containing chemicals. Energy consumption and air emissions also represent significant issues (IPPC 2001).

Utilizing up to 2,000 different chemicals throughout production, from dyes to transfer agents, the industry relies heavily on water for conveying and rinsing these substances. Consequently, the resulting wastewater is laden with chemicals that permeate into the environment (HSRC 2006). Textile mills expel millions of gallons of effluent annually, comprising natural impurities from fibers along with a mixture of process chemicals such as inorganic salts, dyes, and heavy metals.

Chemicals can evaporate into air pollutants, posing inhalation and skin absorption risks. Some carcinogens endanger children and trigger allergies. These pollutants can precipitate, further contaminating surface and groundwater. Conversely, water pollutants can evaporate or seep into the ground (Woodard 2001; HSRC 2006; Lo et al. 2012).

Improperly disposed hazardous solid waste can degrade water quality as leachate contaminates groundwater and soil (Woodard 2001; Lo et al. 2012). Waste treatment can also shift pollutants between categories, complicating management. Furthermore, treatment systems themselves can impact air, water, or soil. Recognizing waste as interconnected processes, comprehensive management is crucial (Woodard 2001).6

3. The impact of improper pharmaceutical waste disposal [7] :

- **Definition of pharmaceutical waste:** Pharmaceutical waste encompasses expired, unused, contaminated, or unwanted medicines. This includes medications, containers holding hazardous drugs, spill clean-up materials, and used protective gear. Categorized by potential environmental and health impact, it includes hazardous, non-hazardous, and chemo pharmaceutical waste.

- Poor storage, handling, and disposal of pharmaceutical waste can severely impact the environment, economy, and human/animal health. Contamination of rivers, lakes, and groundwater from landfills is a major concern. Households, healthcare facilities, and industries

[6] ABDELFATTEH YACOUT (Dalia) "&"; HASSOUNA (Salah) ; (Yacout & SALAH, 2016); Springer International Publishing Switzerland ; No 445; Vol 188 ; Published: 02 July 2016 ; Page "01-13" ; Page "01-02"

[7] NJAGI (Aldress) « & » ;NYAGAH (David Muriithi) « & » ;NYAGAH (Milcah Njoki**); "** (Aldress, David, & Milcah, 2020)Preprints;No245; Vol 1 ; Published 12 October 2020: Page "01-26" : Page "13-14"

must avoid pouring or flushing medications. A South and South-East Asian study found most liquid pharmaceuticals were disposed of through toilets and sinks, while solid waste went into trash bins. These methods have the potential for harmful environmental consequences.

The following outlines some of these repercussions:

- Contamination of water sources for wildlife and domestic animals.
- Improper opioid disposal may contribute to drug abuse, with teens perceiving prescriptions as safer.
- Accidental child poisoning: colorful pills can be mistaken for candy and ingested.
- Risk of falling into the wrong hands, including the public and pets.
- Non-biodegradable drugs disrupt sewage treatment by killing beneficial bacteria.
- Low-temperature or open incineration releases toxic air emissions.
- Facilitation of illegal activities like scavenging, diversion, and resale of expired drugs.
- Soil damage hinders plant growth and may produce toxic plants.
- Improper disposal of infectious waste contaminates landfills and beaches.
- Escalation of healthcare costs due to improper waste management.
- Risk of reputational damage, fines, and license loss for waste generators.

4. Impact of solid waste on health and environment :[8]

4.1. Type of solid waste :

Solid waste comes in various types depending on its origin:

- Residential waste
- Industrial waste
- Institutional waste
- Construction and demolition waste
- Municipal services waste

4.2. Characteristics of solid waste :

- Corrosive wastes contain acids or bases that eat through metal containers, like tanks.
- Ignitable wastes can catch fire easily under certain conditions, for example used oil and solvents.

[8] ALAM (Pervez) « & » ; KAFEEL (Ahmede) ; " (Pervez & Amede, 2013); No: 2315-4721; Vol:2; Published 2013;Page "165-168"

- Reactive wastes are inherently unstable and can explode or release toxic fumes when heated.
- Toxic wastes are harmful or fatal if swallowed or absorbed into the body.

4.3.Causes of increase of solid waste :

- Population growth
- Booming industries
- Urbanization
- Technological advancements fuel demand for resources.

This surge in consumption translates to more household waste generated daily.

4.4.Adverse effects of living organism due to solid waste :

- Communities without proper waste treatment facilities.
- Minors (children)
- Sanitation workers
- Residents near waste sites
- Wildlife

4.5.Points of contact to living organism :

Solid waste interacts with living organisms through:

- Soil adsorption, storage, and biodegradation
- Plant uptake
- Ventilation
- Leaching
- Animals like insects, birds, rats, flies
- Untreated waste dumped in water bodies harming dependent plants and animals

4.6.Impacts of solid waste on human health, animals and aquatic life :

Improper solid waste handling risks both environment and public health. Direct hazards impact waste workers, requiring safety measures to prevent contact with materials. Hospital and clinic waste presents specific risks.

For the public, health risks are indirect, caused by disease-carrying insects like flies and rats. Improperly managed industrial waste mixed with municipal waste further threatens health. Toxic waste spills from accidents can also occur.

Heavy metal concentration in the food chain is a concern. This highlights the link between municipal waste and industrial liquid effluents containing heavy metals dumped in drains or landfills. This creates a vicious cycle, worsening environmental and health problems.

- Inhalation poisoning from harmful chemicals.
- Accumulated waste blocking stormwater runoff, potentially causing floods.
- Increased risk of low birth weight and congenital malformations.
- Elevated cancer and neurological disease susceptibility.
- Nausea and vomiting from exposure to toxins.
- Mercury poisoning from fish with high mercury levels.
- Bird deaths from plastic ingestion in oceans.
- Increased algal blooms in waterways.
- Water and soil quality degradation.

4.7.Impacts of solid waste on the environment :

Waste decomposition pollutes developing nations most, due to lax environmental standards and limited budgets for proper landfills. Rapid urbanization worsens this challenge.

Landfill gas, a major concern, contains methane, a potent greenhouse gas, released during anaerobic decomposition by bacteria. Methane can reach 50% of landfill gas at peak decomposition (Cointreau-Levine, 1997).

Liquid leachate management in developing landfills varies, threatening water sources. Lining landfills with clay and plastic sheeting is considered best practice, encouraging evaporation and preventing soil infiltration.

Section 3: Techniques and ways of waste management

Last but not least, in this 3rd section I will give you the existing methods of waste management starting with the definition of waste management:

1. Definition of waste management:[9]

- The United Nations Environmental Program (UNEP) defines waste management as a comprehensive "framework of reference for designing and implementing new waste management systems and for analyzing and optimizing existing systems" .This definition emphasizes the structured approach needed for handling waste, encompassing planning, implementation, and evaluation of waste management systems.
- Further refining the concept, the New Zealand Waste Strategy defines waste as "any material, solid, liquid or gas, that is unwanted and/or unvalued, and discarded or discharged by its owner". This broader definition highlights the diverse forms and sources of waste that require effective management to minimize environmental impact and promote sustainability.

2. Evolution of waste management :[10]

2.1.The Throwaway Culture:

- The development of material well-being in the 1900s led to the emergence of a throwaway culture.
- This culture was characterized by carelessness towards resources and the environment.
- Historical examples show how formerly productive regions were exhausted and abandoned due to overexploitation of resources.

2.2.The Need for Managing Waste:

- Dumping of unwanted materials was the common practice, leading to negative impacts such as pollution and eutrophication.
- Managing solid waste efficiently became a crucial municipal duty over time.
- The concept of 'robbery' in environmental sociology refers to overexploitation of resources and carelessness towards the environment and future resource availability.

[9] SEADON (J.K) ; (J.K, 2006);N12;Vol26; 2006; Pages 1327-1336
[10] (Pekka, Olli, & Jussi, 2022),01/05/2024 , consulted at 20:51.

2.3.Transition to Circular Economy:

- The shift towards a circular economy aimed to maximize the service produced from material and energy flows.
- Circular economy principles include using cyclical material flows, renewable energy sources, and cascading-type energy flows.
- Waste management value chains and Product-Service Systems (PSSs) are considered attractive business models within the circular economy framework .

2.4.Practical Steps in Waste Management Evolution:

- Practical steps in waste management have been based on growing awareness and gradual development of general opinion supporting changes towards reuse and circulation.
- Societal structuring, including shifting legislation, European Union (EU) and national norms, incentives, and motivation by subsidies, have been crucial in promoting the circular economy .

3. Preventive measures for reduction of adverse impact on environment and human:[11]

Proper solid waste management safeguards the environment and public health. Household waste segregation is key, separating organic waste for composting, the ideal disposal method. Organic waste, prone to faster decomposition and attracting pests, can be composted and used as fertilizer. These steps prevent negative environmental impacts.

- Reduce waste generation at the source.
- Encourage minimal post-use waste from products.
- Boost material recycling and recovery efforts.
- Advocate for clear plastic recycling labels for easier sorting.
- Improve municipal waste sorting services.
- Increase education for producers, public, and waste workers.
- Promote less hazardous production chemicals.
- Strengthen waste sector legislation.
- Ensure safe collection of hazardous waste at designated points.

[11] ALAM (Pervez) « & » ; KAFEEL (Ahmede) , op;cit , page 168.

4. Management of pharmaceutical waste:[12]

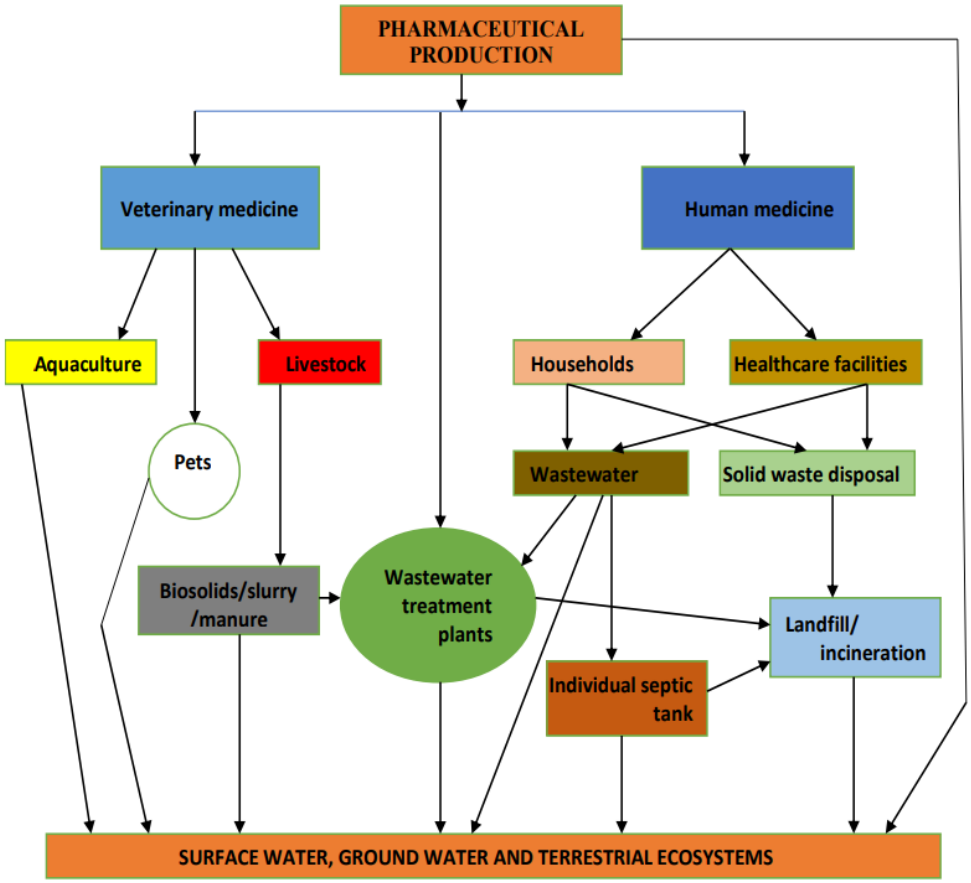

Figure 01: Sources and release of pharmaceuticals into the environment

Source: "Pharmaceutical waste: Overview, Management, and Impact of improper disposal"; Preprints;No245; Vol 1

4.1.Cost of disposal :

- High-temperature incineration (over 1200°C) is the typical disposal method for pharmaceuticals.
- Developed nations like Bosnia and Croatia charge $2.2-$4.1 per kilogram for disposal with advanced incinerators.
- Pharmaceutical waste disposal costs range from $4.4-$8.2 million in the USA.
- India allocates 0.5-2% of its pharmaceutical revenue for such disposal.
- Kenya's costs went from Sh200-400 per kilogram in the 1990s to Sh25-30 currently.

[12] NJAGI (Aldress) « & » ;NYAGAH (David Muriithi) « & » ;NYAGAH (Milcah Njoki), op;cit,"page 08-17"

- In 2017, Kenya disposed of 65,000 kg of waste (Sh1.29 million) at an approved incinerator.
- Only KEMRI (3000°C) and KNH (1700°C) have high-temperature incinerators. Most Kenyan facilities use low-temperature (300°C) incinerators and outsource due to cost.
- The pharmaceutical industry lacks incinerators and returns unused products to manufacturers before expiry.
- A Greek study showed daily generation of 22,900 grams of cytostatic waste (274.8 kg annually). This translates to 140 grams per patient and 210 grams per bed daily. Such studies help plan disposal costs and assess environmental impact.

4.2.Measures of disposing of pharmaceutical waste recommended by the WHO:

- The World Health Organization (WHO) : established in 1948, is a UN agency for international public health. Headquartered in Geneva, Switzerland, WHO's mission is to ensure the highest possible level of health for all people. It works on various health issues, leading global health matters, shaping health research, setting standards, providing technical support to countries, and monitoring health trends. WHO plays a crucial role in coordinating responses to health emergencies, promoting health equity, and advocating for universal health coverage.
- The Pharmacy and Poisons Board (PPB): Kenya's Pharmacy and Poisons Board (PPB) regulates pharmacy practices, drug and poison trade, and ensures pharmaceutical products meet safety, quality, and efficacy standards. They safeguard public health by licensing pharmacists, pharmacies, and drug outlets. Additionally, the PPB registers and regulates pharmaceutical products, approving new drugs and monitoring their distribution and use.
- The Environmental Protection Department (EPD): Hong Kong's Environmental Protection Department (EPD) safeguards the environment. The EPD formulates policies, enforces environmental laws, and oversees initiatives in waste management, air quality, water quality, nature conservation, and pollution control. Regarding pharmaceutical waste, the EPD oversees proper disposal and issues guidelines for safe management of expired medicines by licensed traders.
- The National Environment Management Authority (NEMA): is a Kenyan government agency tasked with coordinating the country's environmental management. NEMA plays a critical role in promoting sustainable environmental practices to protect Kenya's natural resources and ecosystems. This involves conducting environmental impact assessments, monitoring and enforcing environmental regulations, and fostering public awareness and

participation in conservation efforts. NEMA collaborates with various stakeholders, including government agencies, industries, communities, and non-governmental organization, to address environmental challenges and promote sustainable development.

7 Steps to Dispose of Unwanted Drugs:

1. Decision: Facilities decide when to dispose of accumulated pharmaceutical waste.

2. Approval: Authorization is required.

- Kenya: Oversight by NEMA & PPB. Complete disposal form, pay fee (2,500 Ksh) to PPB, receive Drug Safe Disposal Certificate.

- Hong Kong: Apply to EPD as waste generator. Get waste generator number. Pay collection fee, receive trip ticket upon collection.

3. Planning: Ensure funds, personnel, skills, time, equipment, and disposal methods are available. Estimate waste volume (weight per quantity) using a conversion factor (0.2 metric tons per cubic meter).

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4.3.Methods of disposing of pharmaceutical waste:

Eight methods exist for pharmaceutical waste disposal: return to donor, incineration, immobilization, landfilling, sewer disposal, chemical decomposition, open burning, and watercourse release.

4.3.1. Return to Donor:

Large, problematic items like antineoplastic or unwanted donations go back to the manufacturer or donor for proper disposal. Cross-border transfers, regulated by the Basel Convention, move waste internationally but face lengthy approval times.

4.3.2. Landfilling:

Landfilling directly disposes of untreated waste in designated sites. It's the most common method, with landfills categorized into three types:

a. Open, uncontrolled dumps are common in developing countries but unsuitable for untreated waste. Use them only after immobilization or mix waste with municipal trash to deter scavenging. Locate these dumps away from water sources to prevent pollution.

b. Engineered landfills are the second-best option for immobilized waste. They minimize aquifer contamination through design.

c. Heavy-duty sanitary landfills are the safest option. Meticulously built and positioned above water tables, they isolate waste from watercourses. Compression and soil cover maintain sanitation.

4.3.3. Waste Immobilization:

Encapsulation and inertization are the two methods used for immobilization.

1. **Encapsulation:** Waste is embedded in concrete within a drum. Here's the process:
   a. Clean unused drums (avoid those for explosives).
   b. Open and bend back drum lids.
   c. Fill drums with various waste (up to 75%) including solids, liquids, powders, or certain drugs.
   d. Mix cement, lime, and water (15:15:5) and adjust water for consistency.
   e. Securely weld the lid.
   f.Place drums at landfill base and cover with fresh waste.
2. **Inertization:** This cost-effective method uses basic equipment (grinder, concrete mixer, cement, lime, water) for solid/semi-solid waste, drugs, powders, etc. Here's how:
   1. Wear protective gear (gloves, masks).
   2. Separate packaging (blister packs, plastics) from drugs.
   3. Blend waste, water, lime, and cement for a uniform mix.
   4. Transport the mix to a landfill using a concrete mixer truck.
   5. Pour the mix into or distribute it within urban waste.

4.3.4. Sewer disposal (diluted liquids, IV fluids, and limited disinfectants/antiseptics only). Not for undiluted antiseptics/disinfectants or antineoplastic.

4.3.5. Open burning (small quantities, avoid low-temp to prevent air pollution). Works for paper/cardboard packaging, not for PVC materials.

4.3.6. Chemical decomposition (requires expertise, not for incineration). Time-consuming, specific chemicals needed. For antineoplastic <50kg, follow manufacturer instructions.

4.3.7. Incineration: Medium or high-temperature combustion methods:

a. Medium-temperature incineration handles solids, semi-solids, powders, and controlled substances.

b. High-temperature incineration expands on this, accepting liquids, antineoplastic (cancer treatment drugs), in addition to the materials suitable for medium-temperature incineration.

4.4.Techniques for Reducing Pharmaceutical Waste's Environmental Impact:

- Active Pharmaceutical Ingredient (API): is the essential component in a drug that produces its therapeutic effect. APIs are the key ingredients delivering the intended medical benefits for treating specific conditions.
- Limited research exists on environmental effects of pharmaceuticals. Drug companies focus on patient health during trials, with 88% of medications lacking environmental toxicity data. Countries like the Netherlands and France address this issue with strategic plans.

Mitigation needs tailoring across the pharmaceutical lifecycle for lasting benefits and cost-effectiveness, focusing on the following steps:

a) Cross-cutting: Government to focus on high-risk drugs, collaborate with industry and research on water quality monitoring, risk assessments, and modeling. Clear guidelines for "pharmaceutical water" and environmental quality standards are needed.

b) Design: Pharma companies to develop green pharmacies and create environmentally friendly drugs and therapies.

c) Authorization: Government to regulate and assess environmental risks before approving medications. High-risk drugs may require stricter conditions for market launch. Industry to provide risk intervention options, eco-labeling, post-approval monitoring, and mitigation strategies.

d) Production: Government and industry to establish environmental criteria for effluent discharge, wastewater disclosure, and ethical production practices.

e) Consumption: Healthcare sector to prescribe environmentally friendly and personalized drugs, minimizing unnecessary prescriptions. Public awareness through eco-labeling for self-selection of drugs is crucial. Government to prohibit high-risk practices like antibiotic use in livestock and growth hormones. Healthcare facilities to improve livestock management, hygiene, and diagnostics to minimize emissions.

f) Collection and Disposal: Solid waste management to utilize anaerobic digestion and passive manure storage. Industry to introduce schemes for processing unused or expired medicines. Public education to discourage dumping drugs in toilets and sinks.

g) Upgrading wastewater plants (WWTPs): is crucial for detecting pharmaceutical traces.

h) Drinking water treatment: requires water safety planning and modernizing plants. Traditional methods (CCWTTs) struggle with stable drugs like ibuprofen, creating toxic byproducts.

A Serbian study showed lifecycle assessments effectively control household waste.

Minnesota's waste reduction projects saved money and reduced waste by minimizing excess and expired medicines.Recent research suggests incorporating cultural perspectives into disposal strategies. Understanding social, economic, and political contexts explains why medications are prescribed, consumed, and disposed of differently across populations. Cultural preferences also influence how pollution is monitored and reported.

5. Other waste management techniques :

5.1.Recycling:[13]

The familiar recycling symbol holds considerable weight. First, it informs consumers that the packaging can be recycled. Second, it implies that recycling is not just feasible but also the user's responsibility to maintain material circulation. Finally, it acts as a reminder of the complex recycling processes that follow the consumer's action, once the product reaches a recycling center. Concerning organic waste , paper , glass , aliminum , plastic , mining e-waste, industrial waste…

5.1.1. Organic Waste :

From food scraps and fallen leaves to animal remains, our environment teems with organic waste. Though seemingly inert, this waste decomposes naturally with the help of bacteria and fungi. By harnessing this process, we can transform organic waste into valuable

[13] (Arne, 2019);**Recycling ;** MIT Press;2019;210 page.

resources like soil, fertilizer, energy, or heat through proper techniques. This approach represents a fundamental form of recycling.

5.1.2. Paper:

Throughout history, people engaged in recycling practices to make paper. Initially, materials like papyrus and parchment were used for writing. However, as the demand for paper grew, papermakers turned to recycling methods. For instance, in the late sixteenth century, British papermills relied on rags, particularly worn-out linen cloth, as the primary source of cellulose for paper production. These rags were cleaned, fermented, shredded, and mixed with water to create pulp, showcasing an early form of recycling in the paper industry.

The introduction of the Hollander beater by Dutch papermakers in the mid-1600s further exemplified recycling in papermaking. This mechanical device allowed for the efficient breakdown of rags into pulp, enabling the creation of cheaper and higher-quality paper by reusing materials that would have otherwise been discarded. Additionally, innovations by papermaker Matthias Koops in the eighteenth century, such as experimenting with ragless papers and utilizing recycled materials like straw paper and wood pulp, demonstrated a commitment to recycling practices in the production of paper.

Overall, the history of papermaking illustrates how recycling played a crucial role in the industry, from utilizing discarded rags as a source of cellulose to exploring alternative materials and innovative techniques to reduce waste and promote sustainability in paper production.

5.1.3. Plastic:

The complexity of plastics recycling lies in the fact that plastics are not a singular entity but rather a diverse range of materials, each possessing unique properties. Technically, plastics consist of synthetic or partially synthetic polymers, primarily derived from petrochemicals, although certain bioplastics utilize organic materials. Due to this diversity, each type of plastic necessitates specific processing methods for recycling.

Identify plastics using the number inside the recycling triangle:

- PET (polyethylene terephthalate): Common in bottles and widely recycled.
- HDPE (high-density polyethylene): Used for food packaging due to low chemical leaching.
- PVC (polyvinyl chloride): Chemical and bacteria resistant, used in medical supplies, flooring, pipes, shower curtains, and car dashboards.
- LDPE (low-density polyethylene): Durable and flexible, often found in plastic bags, wrapping, and wires. Less commonly recycled.
- PP (polypropylene): Temperature resistant, used for packaging requiring heating or cooling.

- PS (polystyrene or Styrofoam): Common in packaging and disposables like cups and trays.
- "Other": Encompasses various plastics difficult to recycle.

5.1.4. Mining e-waste:

E-waste from electronics poses a material problem. Our devices pack a mix of plastic, metal, circuit boards, wires, rare earth minerals, and gold into ever-shrinking casings, often glued together. While technically recyclable, practicalities make it difficult and labor-intensive. The issue worsens as electronics become obsolete faster, driving higher consumption. Cell phones and computers, crucial for modern life, come with vast supporting infrastructures. We're literally and metaphorically intertwined with electronics and the resulting e-waste.

5.2. Waste to energy "WTE":[14]

Waste-to-energy" (WTE) refers to the process of extracting energy from waste materials, converting them into usable forms such as heat, electricity (through the use of gas or steam turbines), or fuel. These technologies offer viable solutions to address waste management challenges, offering sustainable and economically feasible options, particularly in developed countries.

5.2.1. Why WTE ?

Waste-to-Energy (WTE) technologies offer several benefits:

- Addressing Energy Demand: WTE diversifies energy sources, meeting growing energy needs and reducing reliance on conventional sources.
- Improving Waste Management: WTE provides solutions for managing municipal solid waste, mitigating challenges of improper disposal and landfilling.
- Harnessing Renewable Energy: MSW becomes a valuable renewable energy source in WTE processes, contributing to sustainable energy generation.
- Mitigating Greenhouse Gas Emissions: WTE reduces greenhouse gas emissions by diverting organic waste from landfills and capturing methane for energy production.
- Reducing Environmental Impact: Anaerobic digestion, incineration, pyrolysis, and gasification offer environmentally sound methods for extracting energy from waste while minimizing environmental degradation.

5.2.2. Waste-to-Energy Technologies :

- Incineration: Burning waste at high temperatures generates heat for electricity production, commonly used in developed countries.

[14] (Atul & Sukha , 2022);Elsevier; Volume 69, November 2017, Pages 407-422.

Incineration is a controlled combustion of wastes at high temperatures, widely used in thermal conversion technology. The process reduces waste mass and volume by 70% and 90%, respectively, while also producing heat and/or electricity. Incineration involves stages such as drying and degassing, pyrolysis and gasification, oxidation, energy recovery, and air pollution control. The emissions from waste incinerators have been reduced significantly, making incineration a cleaner source of energy.

- Pyrolysis: This thermal process decomposes organic materials (without oxygen) into bio-oil, gas, and char, offering promise for waste-based energy generation.

Pyrolysis is an advanced thermal treatment method that occurs in the temperature range of 400–800 °C in the absence of oxygen. The process produces pyrolysis gas, oil, and char, with the yield and quality depending on factors such as heating rate, process temperature, residence time, waste composition, and particle size. At lower temperatures (500–550 °C), the main products are pyrolysis oil, wax, and tar, while at higher temperatures (>700 °C), pyrolysis gases are the primary products. The quality of the products is influenced by the specific type of wastes being processed.

- Gasification: High temperatures with controlled oxygen/steam convert organic materials into syngas (synthesis gas) used for electricity, heating, or biofuel production.

Gasification is a thermal conversion technology where organic compounds are converted into syngas in a controlled atmosphere of oxygen at high temperatures. The main product of the gasification process is syngas, which can be used for energy production through combustion or as feedstock for chemicals and liquid fuel. Gasification has been widely used in the coal industry and is now considered a potential energy recovery option for municipal solid waste.

- Anaerobic Digestion: Decomposing organic materials in an oxygen-free environment produces biogas, used for electricity generation or as renewable natural gas.

This process produces biogas and stabilizes the sludge. The quality of the generated biogas depends on process parameters and substrate composition, typically consisting of 50–75% CH_4, 25–50% CO_2, and 1–15% of other gases. The produced slurry/sludge can be used as a soil conditioner or organic amendment in agricultural fields

- Landfilling with Gas Recovery: Methane gas from decomposing organic waste in landfills is captured and used as an energy source.

Landfilling with gas recovery is a process of controlled waste disposal on land to reduce negative environmental impacts through biogas recovery and leachate management. The organic matter in deposited wastes undergoes biological and chemical decomposition, leading to the production of landfill gas (LFG). The degradation of organic matter into LFG occurs in

five phases: hydrolysis/aerobic degradation, hydrolysis and fermentation, acidogenesis/acetogenesis, methanogenesis, and oxidation. The LFG production rate inside a landfill depends on various factors such as waste composition, climatic conditions, moisture content, waste age, and type of landfill.

Each approach offers advantages and challenges for converting waste into energy, contributing to sustainable waste management.

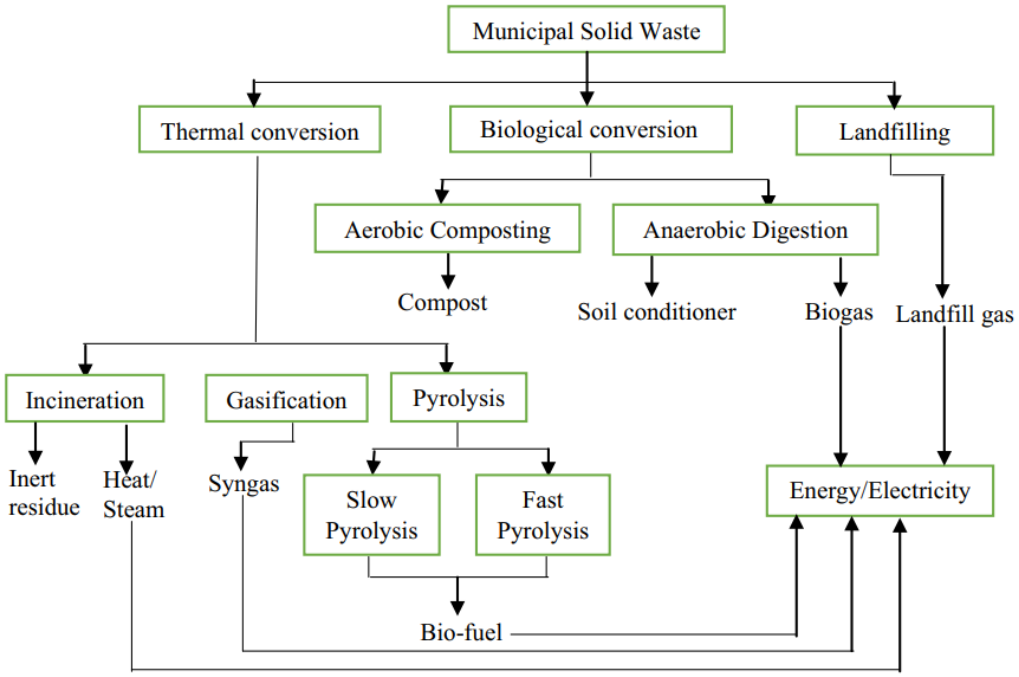

Figure 02 : Municipal solid waste treatment techniques and their products

Source: "A review on technological options of waste to energy for effective management of municipal solid waste " ;Elsevier; Volume 69, November 2017, Page 412.

5.2.3. Challenges of WTE:

- Social Resistance: Concerns about potential toxin emissions from WTE plants lead to societal opposition to their construction.
- High Costs: Establishing and operating WTE facilities requires significant funding, posing financial barriers.
- Funding Challenges: Securing funding for WTE projects can be difficult, hindering development and operation.

- Community Protests: Local communities, especially in densely populated developing countries, may protest against WTE facilities, impacting acceptance and rollout.
- Technology Selection: Choosing the most appropriate WTE technologies for various waste streams is crucial, as not all technologies work with every type of waste.

5.3.Composting:[15]

Composting is the natural decomposition of organic waste like food scraps, yard trimmings, and agricultural residues. Microbes like bacteria, fungi, and actinomycetes break down this matter into nutrient-rich humus. This sustainable practice reduces landfill waste, lowers greenhouse gas emissions, and creates a valuable soil amendment for agriculture and gardens.

5.3.1. Composting Benefits: Waste Diversion, Soil Health, and Sustainability:

- Waste Management: Diverts organic waste from landfills, reducing environmental impact and transforming it into valuable biofertilizers and soil amendments.
- Soil Health & Agriculture: Enriches soil with organic matter, improves structure, enhances nutrients, and promotes beneficial microbes, leading to increased agricultural productivity, biodiversity, and overall soil health.
- Environmental Protection: Reduces presence of microbes and pollutants compared to landfills, preventing groundwater contamination and contributing to pollution prevention, erosion control, and wetland restoration.
- Sustainable Practices: Supports food security, reduces reliance on synthetic fertilizers, and promotes a circular economy by recycling organic waste back into the soil.

Composting is a valuable tool for waste management, soil health, and environmental sustainability, making it crucial for a greener future.

Table 02: Comparison between composting and conventional waste management.

Composting	Conventional
Composting contributes significantly to environmental sustainability. By binding soil particles together, it acts as a natural defense against erosion. This organic	Conventional waste management methods like open dumps, river and ocean dumping, sanitary landfills, and incineration all contribute to environmental degradation. These methods

[15] MODUPE (Stella Ayilara) & OLUWASEYI (Samuel Olanrewaju) & OLUBUKOLA(Oluranti Babalola) ; **"Waste Management through Composting: Challenges and Potentials"**; Sustainability; 12; 4456; Published: 30 May 2020;pages 01-23

process creates a controlled environment where waste is recycled into a valuable product – nutrient-rich compost. Beyond its role in waste management, compost also aids in the bioremediation of polluted soil. Additionally, the presence of compost fosters increased biodiversity by attracting beneficial insects, bacteria, and fungi that contribute to healthy plant growth. Unlike landfills where waste can accumulate for extended periods, composting offers a managed solution that avoids long-term storage problems.	pollute the soil, air, and water bodies, releasing unpleasant odors and creating unsightly landscapes. Furthermore, burying waste in landfills poses a risk of contaminating underground water sources.
Contributing to healthy plant growth. Compost can even suppress diseases in plants while enriching the soil's nutrient content.	Animal feeding, incineration, open dumps, and river and ocean dumping all create environments that harbor pests, pathogens, and insects. This poses a significant threat to human and animal health.
Composting helps reduce greenhouse effects by mitigating the production of gases like methane. While CO2 is released during composting, the amount is significantly lower compared to other waste management methods that involve combustion.	Burning waste (combustion) significantly contributes to the greenhouse effect.
Drastically reduces waste volume	Improper waste disposal methods, like open dumping on land, in rivers, or oceans, lead to the accumulation of waste, resulting in growing volumes.
Polythene bags, plastics, and other recalcitrant substances are not suitable for composting.	Incineration can treat plastics, polythene bags, and similar materials, despite concerns about their contribution to environmental pollution.

Source:"Waste Management through Composting: Challenges and Potentials"; Sustainability; 12; 4456; Published: 30 May 2020;page 05.

6. Municipalities improve waste collection efficiency :[16]

- Data-Driven Planning: Precisely estimating and monitoring waste characteristics (volume, composition), collection points, and vehicle utilization allows for designing the most economical waste collection system.
- Optimized Infrastructure: Analyzing and optimizing collection points and bins based on data ensures efficient waste collection processes and avoids unnecessary costs.
- Technology-Aided Management: Utilizing software tools for route optimization and cost calculations based on specific data helps identify cost-effective strategies for different areas.
- Benchmarking and Performance Improvement: Implementing benchmarking tools and variance analysis allows municipalities to compare their performance against established standards and pinpoint areas for improvement, leading to data-driven decisions for boosting efficiency and reducing costs.
- Enhanced Citizen Recycling: Encouraging and increasing citizen participation in recycling programs is crucial. Higher recycling rates directly translate to a decrease in mixed waste collection, significantly lowering overall expenses. Municipalities can achieve this through awareness campaigns and incentive programs.
- Sustainable Waste Management Practices: Meeting legislative recycling targets is essential for effective and sustainable waste management. Municipalities can achieve this by aligning solid waste management programs with established regulations and promoting responsible waste disposal practices.

By implementing these comprehensive strategies, municipalities can significantly improve waste collection efficiency, reduce costs, and contribute to a more sustainable future.

[16] BOSKOVIC (Goran) & JOVICIC (Nebojsa) & SIMOVIC(Vladimir) & SASA (Jovanovic); "**Calculating the costs of waste collection: A methodological proposal**"; Waste Management & Research;No08;Volume 34; published July 11, 2016 :Page 1-9 (Goran, Neboisa, Vladimir, & Jovznovic, 2016)

7. Methods and tools for measuring the financial performance of waste management:[12]

By utilizing the following methods and tools, municipalities and waste management companies can gain valuable insights, optimize operations, and enhance cost-effectiveness in waste collection and disposal:

- Full Cost Accounting (FCA): This method calculates all costs associated with waste management, including direct and indirect expenses. D'Onza et al. (2016) developed a FCA tool to illustrate its application in Italian municipalities.
- Mathematical Modelling: Models analyze costs and life-cycle aspects of municipal solid waste collection. Barlaz et al. (1995) discussed its effectiveness in assessing financial performance within integrated waste management.
- Management Tools: Tools like Excel spreadsheets can calculate waste collection time and costs based on specific data. These tools provide a structured approach to financial analysis and decision-making.
- Benchmarking and Variance Analysis: These tools compare financial performance against industry standards or previous data. By identifying cost variances, municipalities can improve efficiency.
- Environmental and Economic Assessment: These assessments analyze the financial implications of waste management strategies. Larsen et al. (2010) researched waste collection systems for recyclables, considering both environmental and economic factors to determine financial performance.
- Optimization Studies: Studies focused on optimizing waste collection processes, like determining the optimal number of collection points, can improve financial performance. Boskovic and Jovicic (2015) highlighted the financial benefits of such optimization efforts.

8. How do economies of scale and cost drivers differ across different types of waste in waste management systems?[17]

Economies of Scale and Cost Drivers Can Vary Across Different Types of Waste in Waste Management Systems

- Economies of Scale:

[17] MODUPE (Stella Ayilara) &; OLUWASEYI (Samuel Olanrewaju) &; OLUBUKOLA(Oluranti Babalola), op;cit ,page"01-23"

- Definition: Economies of scale refer to the cost advantages that waste management systems can achieve as the scale of operations increases. This means that the average cost of waste management per unit decreases as the volume of waste handled increases.

- Variation Across Waste Types: Different types of waste, such as recyclables, organic waste, and mixed waste, may exhibit varying economies of scale. For example, the cost efficiencies gained from managing a large volume of recyclables may differ from those associated with handling organic waste or mixed waste.

- Impact on Cost Reduction: Economies of scale can lead to cost reductions in waste management by spreading fixed costs over a larger quantity of waste. This can result in lower average costs per unit of waste managed.

- Cost Drivers:

- Definition: Cost drivers are factors that significantly influence the costs of waste management operations. Identifying and understanding these drivers is essential for optimizing cost-effective waste management strategies.

- Differences Across Waste Types:

- Recyclables: The cost drivers for recyclables may include factors such as sorting, processing, and transportation. Efficient sorting and processing technologies can impact the overall cost of managing recyclable materials.

- Organic Waste: Cost drivers for organic waste management may involve composting facilities, transportation for organic waste collection, and odor control measures. Effective management of organic waste requires addressing these specific cost drivers.

- Mixed Waste: Managing mixed waste involves a combination of disposal, recycling, and treatment processes. Cost drivers for mixed waste may include landfill disposal fees, recycling facility costs, and treatment technologies.

- Impact on Cost Variation: The differences in cost drivers across waste types can lead to variations in the overall cost structure of waste management systems. Understanding and addressing these cost drivers are crucial for optimizing financial performance.

- Financial Implications.

- Optimizing Operations: By recognizing the economies of scale and understanding the specific cost drivers associated with different waste types, waste management systems can optimize their operations to achieve cost efficiencies.

- Strategic Decision-Making: Tailoring waste management strategies based on the cost implications of different waste types can help in making informed decisions to reduce overall costs and improve financial performance.

- Continuous Improvement: Continuously evaluating economies of scale and cost drivers across various waste streams allows waste management systems to adapt and improve their cost-effectiveness over time.

Conclusion:

In conclusion, the chapter began by providing a clear definition of waste, outlining its various types and classification systems. Following this, the second section explored the multifaceted ways in which waste impacts the environment. Finally, the chapter turned its attention to waste management, tracing its evolution throughout history. It concluded by discussing solutions for handling waste through "waste management" practices, including various methods, techniques, and disposal options. The chapter also addressed the associated costs and environmental impact of waste disposal.

Chapter 02: Presentation of the SAIDAL Group

Section 01: SAIDAL Group

1. History of SAIDAL:

Like all major industrial companies worldwide, SAIDAL has undergone several restructurings during its existence.

These multiple transformations (organic, industrial, legal and financial) were decided upon by the public authorities, and gave rise to new ways of organizing the company in line with the prevailing development model for the national economy.

The current organization of the SAIDAL Group is the legacy of a long evolution and a series of mutations and restructurings.

SAIDAL's first production units date back to before independence.

1.1.Before independence: (1954-1962)

BIOTIC: (Gué de Constantine plant) built by Merrel TORAUDE laboratories in 1954.

PHARMAL: built by LABAZ laboratories in 1961.

EL HARRACH: built by the Clin-Midy group and used to extract opium alkaloids and produce suppositories.

1.2.After independence: (1962-1982)

In 1962, the Algerian pharmaceutical sector consisted of the first two production units mentioned above and the general warehouses whose mission was to distribute medicines.

In 1962, EL HARACH was left vacant.

In 1969, Pharmacie Centrale d'Algérie was created following the nationalization of the general stores.

It was created by presidential decree, with the mission of ensuring the state monopoly on the import, manufacture and wholesale marketing of pharmaceutical products for use in human medicine.

In 1971, as part of its production mission, PCH created the El Harrach production unit and acquired Biotic, Pharmal 51%.

In 1974, the El-harrach unit was fitted out, and free medical treatment and care were introduced.

In 1975, the Pharmaceutical Research Unit was created to support the production units in their technical work.

1.3.Between 1982 and 1994 :

In 1982, following the structuring of the PCA (Algerian central pharmacy), the ENPP (national pharmaceutical production company) "SAIDAL" was created by official decree 82.161 of April 24, 1982. It is responsible for the national pharmaceutical industry and its development:

- A monopoly on the manufacture of medicines for human and veterinary medicine.
- A monopoly on the import of basic products for human and veterinary medicine.
- Develop a national pharmaceutical industry.

Promote exports:

In 1984, SAIDAL was transferred from the Ministry of Health to the Ministry of Energy and Petrochemical Industries.

In 1987, commissioning of the MEDEA Antibiotic Complex, built by EDIC, a spin-off from the restructuring of SNIC.

In 1988, the complex was transferred to SAIDAL .

In 1989, SAIDAL became autonomous and became SAIDAL SPA with a capital of DA 8 million from funds held at :

- 40% Mines Hydrocarbons Hydraulics .
- 30% Capital goods.
- 30% Petrochemicals.

In 1992, ONUDI-MEDITAL began production of massive solution units.

In 1993, following the serious crisis in the national drug market between 1991 and 1993, pharmacists launched a three-year international call for tenders to put an end to the shortages.

1.4.Between 1995-1999 :

In 1995, SAIDAL achieved a record year in terms of production, with sales of 81.4 million units. At the same time, SAIDAL encountered overstocking problems for the first time, due to competition from pharmacists; orders placed in 1994, 1995 and 1996 were overestimated and far exceeded requirements. During the same period, the private sector imported large quantities of finished products.

In 1996, to adapt to its new, highly competitive environment, SAIDAL set up :

The Centre Commercial unit to bring all the company's products together in one place and improve sales service.

- The Marketing and Sales department, to raise awareness of the company's products among specifiers and develop the company's image.

In 1997, as a result of the various organizational changes carried out in 1996, a synergy was created between production and sales and significant performances were achieved in these two areas:

- +24% In sales .
- +16% in production.

In 1998, SAIDAL became an industrial group with (3) three production subsidiaries and two service units (Batna and Oran sales units). The aim of this restructuring was to decentralize decision-making. Significant results have been achieved in the following areas:

- +24% in sales .
- +20% in production.
- +42% in net income.

In 1999, SAIDAL continued its transformation to adapt its functions to the demands of the external environment, characterized by the prospect of a totally open national market in accordance with the agreements in preparation for the signing of partnerships with Europe and the WTO.

1.5.Between 2000 and 2006 :

In 2000, a new organization based on five pillars was put in place.

Total focus on customer satisfaction (customer orientation and process management).

Participative management to create synergy between functions.

Sufficient systematic support (policies, procedures).

Control and self-assessment through the creation of control functions.

In 2001 certification of the CRD, head office, Antibiotical subsidiary and Biotic subsidiary to ISO 9001 V 94.

In 2003, creation of the suppository workshop in Batna and certification of all group entities to ISO 9001 version 2000.

In 2006, insulin production was launched, with a production capacity of five million (5 million), representing a value of two (2) billion Dinars.

2. Presentation of subsidiaries and units:

- Antibiotic:

Antibiotics includes the Médéa antibiotic complex, which began production in 1988, producing the following galenic forms: Dry, injection, liquid, pasty, tablets.

- Pharmal:

Pharmal, headquartered in Dar El-Beida, has 3 production units:

- Dar El-Beida.
- Constantine.
- Annaba.

It produces the following galenic forms: Dry, liquid, pasty, toothpaste suspension.

- Biotic:

Biotic is headquartered in EL-HARRACHE and has four production units:

- Gué de Constantine
- El-Harrach
- Cherchell
- Batna

It manufactures the following galenic forms: solid solutions in "clera flex" pouches and glass bottles, suppositories, syrups, tablets, drinkable ampoules and solutions.

- Research and Development Center (CRD):

It develops an average of 5 to 6 generics a year, which are integrated into the production range. The center is responsible for drawing up policy and developing research areas in line with the SAIDAL GROUP's strategic missions in the field of medical sciences, and more specifically in pharmaceutical innovation.

- UCC Business unit:

The Centre business unit was set up in 1996, to market SAIDAL products from a single center and ensure the best for customers.

The group has two other sales units, one in ORAN and the other in BATNA.

3. SAIDAL Group organization:

In January 2014, the SAIDAL Group merged its ANTIBIOTICAL, PHARMAL and BIOTIC subsidiaries by absorption. This decision, approved by its corporate bodies, gave rise to a new organization built around :

- Group General Management

Decision-making structure comprising the central departments:

- Internal Audit Department .
- Program Management Department.
- Strategy and Organization Department.
- Marketing and Sales Department.

- Research and Development Center.
- Bioequivalence Center.
- Purchasing Department.
- Quality Assurance Department.
- Regulatory Affairs Department.
- Information Systems Department.
- Finance and Accounting Department.
- Direction du Patrimoine et des Moyens Généraux.
- Communication Department.
- Operations Department.
- Industrial Development Department.
- Human Resources Department.
- Legal Department.

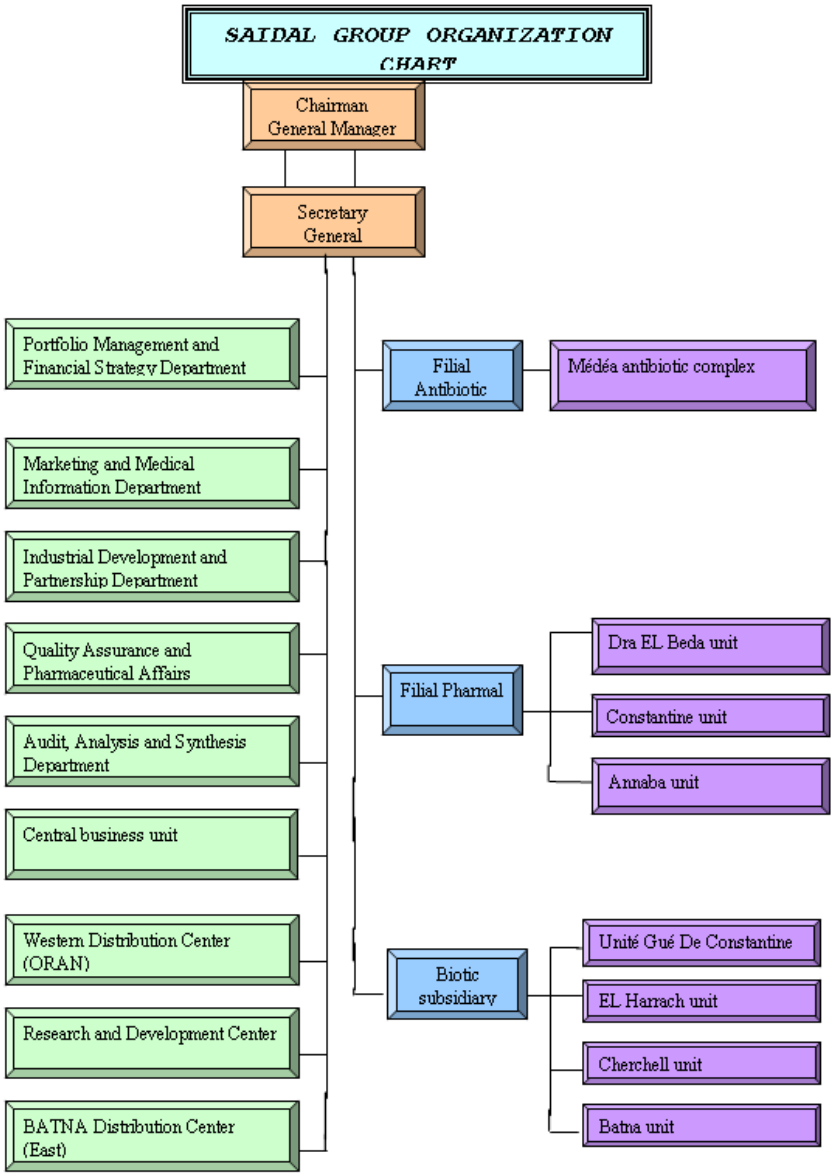

Figure 03 :SAIDAL GROUP ORGANIZATION CHART

Source : Administration internal document

4. Group missions and objectives:

As the leading producer of generic medicines in Algeria, SAIDAL's ambition is to reinforce its leading position in the pharmaceutical market and to be a benchmark player in a highly competitive environment, open to innovation and new technologies, and constantly striving to preserve its brand image and long-term future. The Group's mission is twofold:

- Contribute to protecting the health of citizens and improving the quality of care by providing patients with a rich and diversified range of health care products quality.

- Protect citizens' right to access treatment by adopting a policy pricing system that favors broad segments of society.

As a publicly-owned company, it is also responsible for supporting public health policy in the development of the pharmaceutical industry, by choosing investments geared to satisfying the needs of the population and shareholders, while striving to reconcile public health objectives with management imperatives.

In line with its mission, SAIDAL has defined a number of lines of action to ensure its development:

At the forefront of these lines of action is a global, integrated development plan to enable the Group to grow, with a program of actions focused on enhancing human resources, improving organization and the information system, promoting corporate culture and implementing an effective communications policy. The aim is to:

- Promote ethical rules to regulate and clean up the industry.

drug market.

- Help reduce imports.
- Open up to external markets.
- Increase consumer satisfaction.

The main objectives of the SAIDAL Group are :

- Expand the product range.
- Offer quality medicines and related products at competitive prices.
- Develop partnerships with foreign companies.
- Increase marketing and sales efforts.

5. Production sites:

The Saidal Group has six (6) production sites in Algiers (Dar El Beida, El Harrach and Gué de Constantine), Médéa, Constantine and Annaba. These plants have an average annual output of 140 million sales units.

6. Distribution sites:

Equipped with considerable logistical resources and a young, dynamic and specialized workforce, these Centers distribute SAIDAL products throughout the country.

6.1. Distribution Center:

Created in 1996, it was the Group's first Distribution Center. Its aim was to market and distribute all the Group's products from a single point of sale. Encouraging results led to the creation of two further distribution centers in Batna and Oran.

6.2. Eastern Distribution Center:

Created in 1999 in Batna, this center handles the marketing of SAIDAL products in the Eastern region.

6.3. Western Distribution Center:

Created in 2000 to ensure better distribution of products in the Western region.

7. Subsidiaires and participants :

7.1.Subsidiaries:

7.1.1. SOMEDIAL: Located in the Oued Smar industrial zone, SOMEDIAL is the result of a partnership between Groupe SAIDAL (59%), Groupe Pharmaceutique Européen (36.45%) and FINALEP (4.55).

The SOMEDIAL production unit has three departments:

- A specific department for the manufacture of hormonal products, - A department for the manufacture of liquids (syrups and oral solutions),
- A department for the manufacture of dry forms (capsules and tablets).

7.1.2. IBERAL: IBERAL is a joint stock company resulting from a public/private partnership:

- SAIDAL Group: 60% of sales
- Flash Algérie, food processing specialist: 40% of sales

IBERAL Spa's main mission is to develop and operate an industrial project for the production of pharmaceutical specialties for human medicine.

The IBERAL Spa industrial project has the following objectives:

- Manufacture of generic drugs (injectables and dry forms).
- Drug packaging (solid forms).
- Packaging and quality control services at the request of national producers.

7.2.Participants:

7.2.1. Active pharmaceutical companies:

- WINTHROP PHARMA SAIDAL (WPS)

It was created in 1999 by the SAIDAL Group (30%) and SANOFI (70%) to manufacture, process and market pharmaceutical specialties for human use in Algeria. The W.P.S. production

unit, located in the Oued Smar industrial zone, went into production in December 2000. It currently employs 103 people, and in 2012 produced 24.6 million units for sales of 1.8 billion dinars.

- PFIZER SAIDAL MANUFACTURING (PSM)

Joint venture created in 1998 between the SAIDAL Group and PFIZER Pharm Algérie for the manufacture, packaging and marketing of pharmaceutical and chemical products.

Located in the Oued Smar industrial zone, the P.S.M. production unit went into production in February 2003. It currently employs 63 people, and in 2012 produced 10 million units for sales of 3.7 billion dinars.

8. Pharmaceutical projects in progress:

8.1.SAIDAL-North Africa- Holding Manufacturing-FNI (SNM):

S.N.M. is the result of a partnership concluded in September 2012 between the SAIDAL Group (49%), the Kuwaiti North Africa Holdind Company (49%) and the Fond National de l'Investissement (02%), for the creation of a center specializing in the development, industrialization and marketing of anti-cancer drugs.

8.2.TAPHCO (Tassili Pharmaceutical Company):

The result of a 1999 partnership between the SAIDAL Group (44.51%), ACDIMA, SPIMACO and JPM for the manufacture, marketing and import of pharmaceutical products (injectables, liquids and eye drops).

The TAPHCO production unit, located in the Rouïba industrial zone, went into production in 2014.

8.3.Other investments:

- The SAIDAL Group also has interests in other companies:
- ALGERIE CLEARING (Finance company) 6.67%.
- NOVER (glass production company) 4.46%.
- ACDIMA (Arab Company for Drug Industries and Medical Appliances) 0.38%.

9. Product quality at the heart of management:

The SAIDAL Group, a player and instrument of national public health policy, aims to consolidate its leading position in the pharmaceutical market and to become a benchmark player in a highly competitive environment open to new technologies and innovations, with a constant concern for preserving its brand image and sustainability.

In the Group's strategy, quality is positioned as the central axis around which all management actions are articulated in order to ensure :

- Marketing products that comply with legal and regulatory requirements, particularly in terms of safety, security and efficacy.
- Patient well-being.

The Group's objectives are implemented by constantly observing the fundamental values that make up its Corporate Social Responsibility:

- Citizen solidarity.
- Fairness.
- Integrity.
- Transparency.
- Commitment.

Section2: Presentation of Pharmal subsidiary

Pharmal SPA, a subsidiary of the Saidal Group (hereinafter Pharmal), is an EPE/SPA with a share capital of 800,000,000.00 DA, resulting from the restructuring of Saidal on February 2, 1998.

Pharmal has 03 production plants, located in Dar el Béida

- Constantine - Annaba, which produce and market 54 pharmaceutical products for human use. It produces the following galenic forms: tablets, capsules, ointments, syrups, drops, dermal solutions, powders, toothpastes, injectable solutions and suspensions.

Pharmal has a production capacity of 62,000,000 sales units per year, with sales of 2,442,000 KDA, and employs 967 people.

The Pharmal head office employs 51 workers, and is represented by Mr MOKHTARI Hocine as General Manager of the Pharmal company. The Dar El Beida plant is Pharmal's oldest unit, in existence since 1958, and is represented by Mr MAKSOUD Abdelhakim as Director of the Dar el Beida Enterprise. It belonged to the French laboratory Labaz before its nationalization.

Its activity was limited to the manufacture of a few medicines in various forms. These included tablets, syrups, oral solutions, ointments and powders.

It employs 539 workers and has eight (08) packaging lines with a capacity of 40,000,000 sales units per year.

The company has a quality control laboratory responsible for physico-chemical and microbiological analysis.

The Constantine plant, located in the industrial zone, specializes in the manufacture of liquid forms.

It employs 267 people and has two 02 packaging lines with a capacity of 15,000,000 units a year.

The Annaba plant, located in the wilaya of Annaba, specializes in the manufacture of dry forms. It employs 125 workers and has a packaging line with an annual capacity of 7,000,000 units.

These last two (02) plants were transferred to Pharmal following the dissolution of ENCOPHARM on 12/31/1997.

1. Organization chart of Pharmal headquarters:

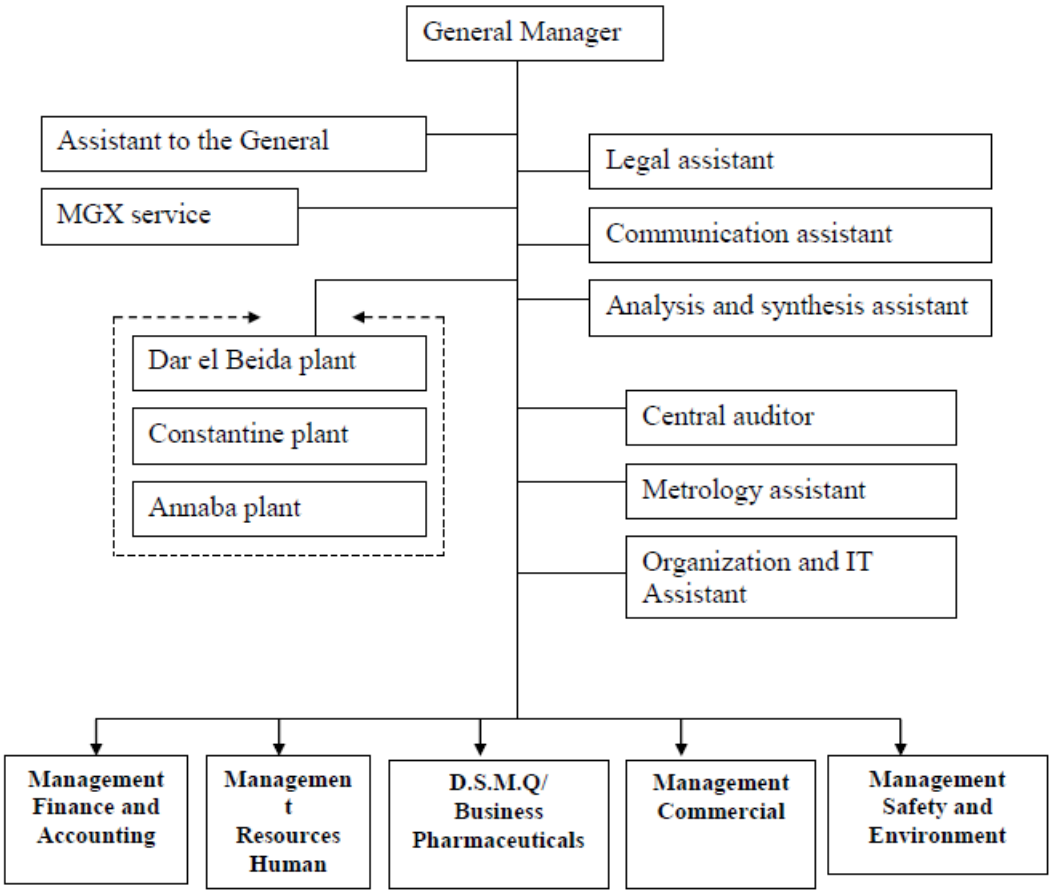

Figure 04 : Organization chart of Pharmal headquarter

Source: Administration internal document

2. Group activities:

The SAIDAL Group focuses on the manufacture and marketing of pharmaceutical products for human use, with the aim of increasing its market share in therapeutic classes that are certain to grow in the medium term: cardiovascular, psychotropic, nervous system, digestive system, respiratory system, antibiotics and bulk solutions in both traditional and new forms.

3. Missions:

- Fully satisfy customers and meet their needs in terms of quality, quantity, lead time and cost.
- Ensuring the best possible return on capital invested and its recovery.

- Enhance the human skills of the SAIDAL Group.
- Produce ever newer drugs that meet the highest standards of quality, efficacy and safety.

4. Strategic objectives of the SAIDAL Group:

- Ensure the position of a leading laboratory at various national and regional levels.
- Expand its range, taking into account market needs in selected therapeutic classes.
- Achieve market shares in excess of 50% in targeted therapeutic classes in Algeria by 2011.
- Export 10% of Group sales (antibiotic raw materials and finished products) by the end of the year.
- Manufacture products for other laboratories with high "therapeutic values", and make the most of our facilities.
- Establish R&D partnerships with local and/or foreign universities.

5. Organizational chart Dar El Beida unit:

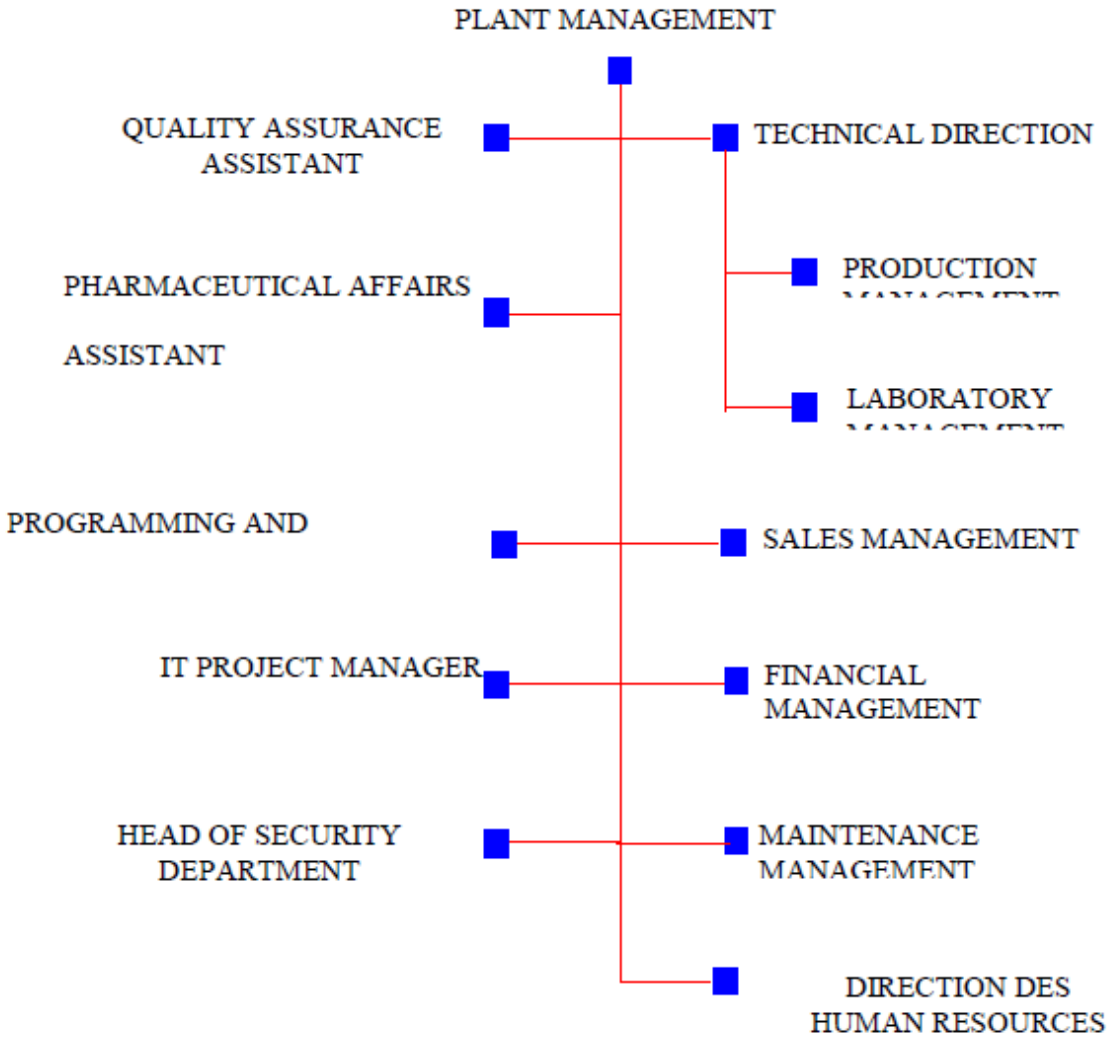

Figure 05 :Organizational chart of SAIDAL Dar El Beida

Source : Administration internal document

Section 03: Inventory Management sub-directorate

In this section, I will be presenting the inventory management sub directorate where I did my internship in SAIDAL

1. The GDS "Inventory Management" sub- directorate :

1.1.Inventory Management departments:

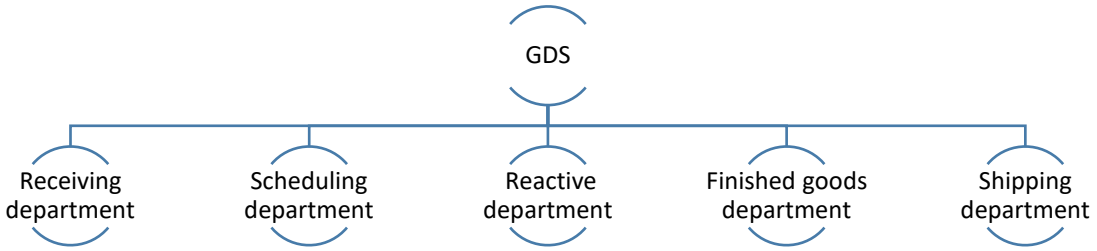

Figure 06 : Different departements of the inventory management sub directorate

1.1.1. Receiving department:

Receiving in the SAIDAL Group goes through 3 steps:

1.1.1.1. **Verification:** of the recovered merchandise and its type, we receive concerning the merchandise (an invoice + fees + certificate of analysis + input voucher).

1.1.1.2. **Entry:** where the received blocked merchandise is stored in the inventory while waiting for the laboratory analysis bulletin "The department head sends an analysis request for this bulletin with a copy of the analysis certificate from supplier to the laboratory to validate and release the blocked merchandise.

An analysis request contains all the information of the received product, on the top half we find "Name, Reference, Manufacturing date , Expiry date, Batch number, time, either its an analysis or reanalysis.." which is filled by the receiver ; while the bottom half is for the laboratory to fill "number of samples collected; time and observation" .

1.1.1.3. **The receipt:** Which is moving the released merchandise to its right place in the inventory.

- The inventory is divided into 4 zones:

1. ZONE A: Storage of Raw Materials.
2. ZONE B: Packaging materials.
3. ZONE C: Final product.
4. ZONE D: Waste stock.

This department contains a sub-department called “Reform” for products, Raw materials…. That are expired or don’t meet the requirements according to the laboratory.

To manage all the inventory SAIDAL uses an intern self-developed software “DISPATCH”.

- ZONE A: Storage of Raw Materials: this part of the inventory is specified for the storage of raw materials that the laboratory confirmed their meeting with the requirements of the order and standards, such as Active Pharmaceutical Ingredients (APIs).
- ZONE B: Packaging materials: suck as blister packs,bottles…
- ZONE C: Final product: after the production team is done with any type of production and the laboratory validates the final product, it is moved to this zone.
- ZONE D: Waste stock: This zone is for any final product/raw material/packaging that is expired &/or refused by the laboratory &/or damaged. It is stocked here until the inventory management decide to either use it for something else or burn it.
- Reform sub-department: This one is either for performing incineration on the waste or a reform.

1.1.2. Scheduling department:

The role of this department is to give packaging/ manufacturing orders and make the month's schedule of production; and it goes through 3 steps:

1.1.2.1. **Planning:** An annual plan is received within the site made by the general management at the beginning of the year "January" and deglobalized according to the batches in programs of the months around the year N.

At the end we will have “A production plan” according to: Availability, capacity and sales.

1.1.2.2. **Production launch:** in order to launch a production of a product there are multiple people and steps involved in the procedure:

- Responsibilities:

• Assistant to the Production Site Manager in charge of Scheduling : Approve and apply the procedure.

• Production assistant: Apply the procedure.

• Quality Assurance Manager: Ensure the implementation and monitoring of its application at the operational level.

- The procedure :

Before getting into it , SAIDAL uses references for each of its documents:

Table03:SAIDAL's documents references.

Reference	Designation
IMP.01	Manufacturing orders
IMP.03	Weekly production schedule
IMP.04	Monthly production schedule
IMP.05	Packaging orders
LB/DSP/001/B	Production launch logbook

Source: SAIDAL's internal document.

Table 04:The process of launching production.

***Person in* charge**	**Task**
1. Scheduling assistant :	- Receive the production and deglobalized sales forecast from the Assistant Site Manager in charge of analysis and synthesis. - Draw up purchase requisitions for local purchases, taking into account raw material and packaging inventories, as well as purchase orders. - Forward the requisition to the Purchasing and Supply Sub-Directorate
2. Scheduling assistant / scheduler :	- Draw up the IMP.04 monthly production schedule in collaboration with the Production Site Manager, the Supply Assistant Manager, the Technical Manager, the Production Assistant Manager, the Laboratory Assistant Manager and the Maintenance Assistant Manager, depending on the availability of raw materials, the predisposition of existing stock equipment and sales forecasts. NB: The production schedule can be adjusted if necessary.

	- Ensure the availability of raw materials and packaging items before each production launch by consulting the Raw Materials;Packaging Items inventory management software via the intranet from Inventory Management.
3. Scheduling Assistant / Scheduling Follow-up Assistant Production Manager :	- Draw up the IMP.03 weekly production schedule in collaboration with the Production Assistant Manager and forward it to the Technical Manager, Production Assistant Manager, Quality Assurance Manager, Quality Control Laboratory Assistant Manager, Supply Assistant Manager and Maintenance Assistant Manager. NB: If the program is revised, update it (order number).
4. Scheduling assistant / scheduler :	- Enter the date on the planning software and print the Manufacturing Order IMP.01 and Packing Order IMP.05 specific to the product to be manufactured in 3 copies (the original and the 2 counterfoils).
5. Scheduling assistant :	- Sign the Manufacturing Orders IMP.01 copies (the original and the 2 counterfoils) and submit them to the Quality Assurance Secretary for stamping with the "quality assurance controlled copy" stamp >>.
6. Secretary - Quality assurance :	- Check the printed Manufacturing Order IMP.01 and Packing Order IMP.05 against the reference Manufacturing Order IMP.01 and Packing Order IMP.05, previously validated by the Quality Assurance Manager and the Technical Director, and stamp them "< quality assurance controlled copy".
7. Scheduling assistant / scheduler :	- Fill in the "< production start LB/DSP/01/B)" log book and send the IMP.01 production order and IMP.05 packaging order to the S/DP for approval.

8. Assistant Production Manager :	- Receive the Production Order/IMP.01 and the oc IMP.05 from the scheduler and acknowledge receipt on the "Production start-up" log book LB/DSP/01/B - Send IMP.01 production orders and IMP.05 packaging orders to the head of the production department.
Ordering raw materials	
1. head of manufacturing department :	- Check the quantities of raw materials for the product to be manufactured on the IMP.01 Production Orders and sign them. - Hand in IMP production orders. 01 to the Deputy Production Manager for signature. - Forward to the head of the central weighing department the production file containing 3 copies of the IMP .01 production orders.
2. Central Weighing Department Manager :	- Send IMP.01 production orders to the Raw Materials department manager for delivery of raw materials.
3. Raw Materials Department Manager :	- Sign IMP.01 production orders and forward to S/D Stock Management for approval. - Deliver raw materials in accordance with Manufacturing Order IMP.01, accompanied by the analysis bulletin.
4. Central Weighing Department Manager :	- Weigh incoming raw materials and fill in: control numbers on analysis bulletins, batch numbers and weighed quantities of raw materials on Production Orders and sign them. - Send one counterfoil of the Manufacturing Order to the Inventory Management Sub-Directorate and insert the original and the counterfoil in the batch file.
Ordering packaging items	

1. Packaging Department Manager	- Check quantities of packaging items on IMP .05 packaging orders and sign jointly with production assistant manager. NB: delivery of items takes place after the product has been manufactured.
2. Head of Packaging/ Head of packaging Department:	- Hand over the IMP 05 Packaging Orders in 03 copies (the original and the 2 counterfoils) to the Head of the Packaging Article Warehouse Department.
3. Warehouse Packaging Department Manager :	- Fill in control numbers, batch numbers and quantities of packaging items on IMP.05s and sign. - forward IMP .05 packing orders to S/D Stock Management for approval
4. Head of the Packaging Department :	- Deliver packaging items in accordance with IMP.05 packaging order. - Keep a counterfoil of the IMP.05 Packing Order and give the original and the counterfoil to the Head of the Packing Article Department.
5. S/D Stock Management :	- Keep a counterfoil of the IMP.05 Packing Order and give the original and the counterfoil to the Head of the Packing Article Department.

Source: SAIDAL internal document.

- The forms:

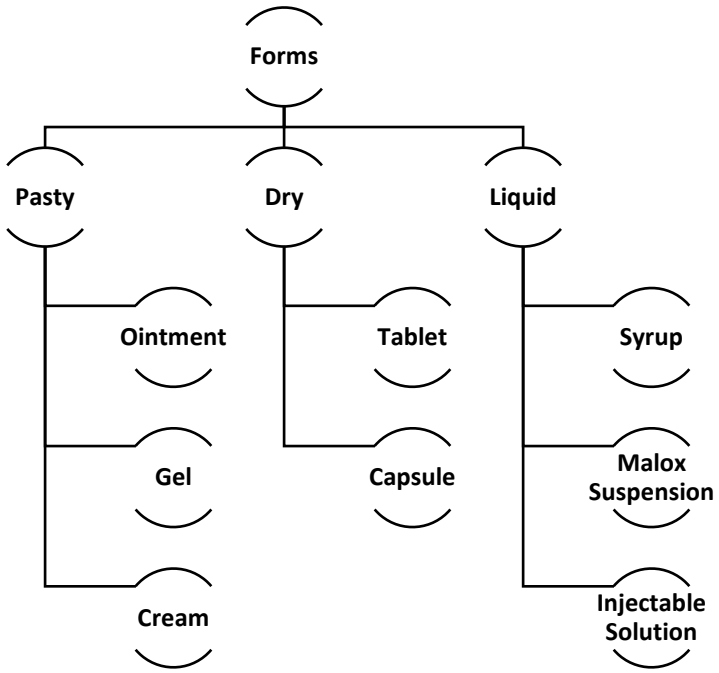

Figure 07 :Different forms of products that SAIDAIL produces

Noticed:

- The software used to follow these steps is: Inventory management "MPAC".
- In order to move pass from a step to another, the laboratory should validate the first step first.

1.1.2. Reliable Lab Supply Department :

This department is based on the receipt and release of laboratory products, either they were reactive products in which they can be liquid or solid or glassware.

SAIDAL stocks each of them in fully equipped room with a code created by the company itself.

- Reactive products : refers to chemicals or substances that undergo chemical reactions, often with other substances.They can be solid such as baking soda, or liquid like ethanol (alcohol).
- Glassware: refers to laboratory equipment made of glass, such as : beakers , test tubes,flasks….

- Procedures for:

➢ Requesting a product from the responsive service:

1- Call from the laboratory to the Reliable Lab Supply Department manager.

2- The manager collects the product from stock and delivers it to the laboratory.

➢ In case of being out of stock:

1- The laboratory calls the supply department.

2- The supply department places orders to suppliers.

➢ In case of receiving a product:

1- Received with an invoice + analysis.

2- Send a copy of these to the supply department.

3- The supply department contacts the accounting department to pay the suppliers.

1.1.3. Finished product department:

SAIDAL uses “in-house” JULIA software for finished product registration

Each finished product is blocked until validation and release of this product by the laboratory so that it can be distributed.

The laboratory sends to the inventory management manager every day before 10 a.m. the status of the blocked batches such as:

- ≤7 batches blocked is normal.
- +7 lots blocked is abnormal.

1.1.4. Shipping department:

This department is only for distributing the finished products.

1.1.4.1. The process:

1- DISPATCH schedule: a sheet in which contains the program of shipping to Blida, Oran and Batna where SAIDAL owns warehouses to stock its products and the redistribute to the whole country, this schedule also contains the date of shipping , the product’s quantity and the total of products that are shipped from SAIDAL DAR EL BEIDA to others.

A copy of DISPATCH is sent to:

- Finished product department manager to prepare orders.
- Head of shipping department to prepare the trucks.
- Deputy Director of Inventory Management for Information.

2- Transport request from assignment.

3- “CAAT” insurance just after the trucks start.

Chapter 03: Studying the toothpaste NATRI BIFLUOR waste

Introduction

The vital role of the pharmaceutical industry in safeguarding human health comes at a cost: waste management. Saidal, a leading Algerian pharmaceutical company, grapples with this challenge like many others. This chapter delves into Saidal's current waste treatment practices, analyzing their effectiveness and pinpointing areas for improvement. We will then dissect the reform process, outlining potential solutions to streamline waste management.

A particular focus will be placed on Natri BIFLUOR, a prevalent yet waste-intensive product used in pharmaceutical manufacturing. We will provide a comprehensive description of Natri BIFLUOR, its properties, and its function within the production process. However, our attention will then shift to the environmental implications of Natri waste.

Through a meticulous examination of Saidal's waste management practices and a detailed analysis of Natri BIFLUOR, this chapter aims to pave the way for a more sustainable future for Saidal's production processes. By critically evaluating current methods and proposing innovative solutions, we hope to contribute to a greener pharmaceutical industry, not just in Algeria, but on a global scale.

Section 01: Reform sub-department

Saidal, a leading Algerian pharmaceutical company, prioritizes public health. However, like many pharmaceutical companies, Saidal's production processes generate significant waste. This section delves into Saidal's waste management practices, specifically focusing on the critical role of the reform sub department. We will examine their existing procedures for waste treatment and identify any potential shortcomings in their current approach.

However, our focus then sharpens on a specific product: Natri toothpaste. While seemingly innocuous, Natri toothpaste production generates significant waste. We will dissect the properties of Natri and its role in toothpaste formulation. More importantly, we will delve into the unique waste challenges associated with Natri toothpaste. By understanding these complexities, we can collaborate with the reform sub department to explore solutions and pave the way for a more sustainable future for Saidal's production processes.

1. Reform sub-department:

The reform sub department is a part of the receipt department in the inventory management sub directorate, it is specialized in performing either an incineration or reform on the product.

In case of incineration there have to be “Presence of a bailiff + a file that contains all the information”.

1.1.Reform folder :

- Non-compliant product status.
- Analysis reports/Technical bulletins.
- Product reform specification/Product compliance sheet.
- Report of the reform commission.

1.2.Responsibility :

Technical Manager and Plant Manager.

1.3.The procedure of non-compliant product reform:

Before getting into it , SAIDAL uses references for each of its documents:

Table05:SAIDAL’s documents references.

Reference	Designation
IMP001	Valued status of non-conforming products (Semi-finished product, Packaging item, Finished product, Raw material): A sheet which contains; the designation of the product, the quantity(KG) , the number of batch, the nature of product, date of expiration , value (DZD) and the observation). This document is signed by the head of the stock management department and endorsed by the sales manager.
IMP002	State of non-conforming products (semi-processed product): a sheet containing the product designation, quantity, batch number, type of product and date of expiry, this sheet is signed by the production manager.
IMP003	Product sheet for reform: a complete document which follows the withdrawal of products from stock. It indicates the type of product (raw material, packaging item, laboratory supply) and its precise designation. The stock manager fills in the supplier details (name, invoice number, delivery date) and the quantity to be culled. Next, a section dedicated to quality control, filled in jointly by several managers, specifies the reason for the reform (defect, obsolescence, etc.), describes the anomalies and mentions the date of the control. Finally, the financial validation and approval of the reform is made by the visa of the finance director and the signature of the production site manager, including the validation date. A "Remarks" field allows you to add additional information. Once completed and signed, this form becomes an essential supporting document for rigorous inventory management and tracking of product reforms.

Source: SAIDAL’s internal document.

Table 06:The process of non-compliant product reform.

Person in charge	Task
1- *Sales manager*	- Draw up a monthly statement (IMP 001), duly stamped, of non-conforming products (raw materials, packaging items, finished products, semi-finished products, etc.) and/or products that have expired. - notice: the Production Department must draw up and send to the Sales Department a statement of non-conforming products (semi-processed product) (IMP 002) together with the analysis reports. - Fill in and sign the product sheet for culling (IMP 003) and send it to the technical manager, together with the analysis reports and the status of non-compliant products (Raw material, Packaging item, Finished product, Semi-finished product).
2- Technical manager	- Put together a file for the reform of non-conforming products - Convene the "commission de réforme des produits non conformes".
3- Reform commission	- Hold a meeting to validate the culling of non-compliant products and draw up a culling report.
4- Laboratory Director/ Quality Management System Manager/ Technical Director	- Complete and sign the parts of the product sheet intended for reforming.
5- Technical manager	- Forward the original reform file to the CFO. Notice: A copy of the reform file must be filed with the technical department.
6- Finance director	- Check the culling file for non-compliant products, fill in and sign the product sheet for culling. - Forward the non-conforming product reform file to the Plant Manager for approval.

Source: SAIDAL internal document.

1.4.The procedures of Biological waste management (decontamination and incineration of vials, test tubes, pipettes, petri dishes, and other materials):

Table 07:The process of Biological waste management.

Person in charge	Task
1- Analyst	1. Decontaminate equipment used for handling micro-organisms by autoclaving at 121°C for 30 minutes. (flasks, test tubes, pipettes, petri dishes, etc.) 2. Complete the decontamination management register, contamination management register and equipment registers. 3. Collect decontamination waste in garbage can liners.
2- Quality Control boratory Manager	-Draw up and sign a release form, and forward it to stock management.
3- Store section nager	-Transporting decontamination waste for incineration -Send a copy of the discharge with acknowledgement of receipt from the organization concerned to the quality control laboratory manager.

Source: SAIDAL internal document.

2. Natri BIFLUOR toothpaste:

Presented as a mint-flavored toothpaste in a 100 g tube, this product belongs to the class of anti-caries prophylactics. Its main indication is the preventive treatment of tooth decay.

2.1. NATRI toothpaste costs :

- Unit price 2024 per unit/1000kg:

- Packaging: 3600DZD. - Tubes :23544 DZD.

Table 08: Costs of NATRI toothpaste.

Type	Cost (DZD)
Packaging	0.36
Empty tube	0.23
Filled tube	125.84
Production	126.2
Factory gate	151.4
Wholesale	166.59
Retail	199.0
Public	199.0+ the margin of the retailer

Source: SAIDAL intern document

2.2. NATRI toothpaste production:

- To start manufacturing NATRI :

Machine name: EWIK1986.

- Manufacturing capacity:

2 batches/day with 2.5h/batch: non-stop.

We need : - batch record - production order.

- NATRI/lot production order: one lot=3 pallets=52 cartons =1250kg=12500 Natri toothpaste.

Table09: Quantity of raw materials needed to produce a batch of NATRI toothpaste.

Raw material designation	Quantity (kg)
Sodium Fluoride	0.275
Sodium Benzoate	50
Sodium Monofluorophosphate	8.538
Sodium Carrageenate	13.750
Sodium Hexametaphosphate	2.5
Sodium Lauryl Sulfate Needle	25
Simple Nipagin	1.25
Titanium Dioxide	9.375
Sodium Saccharinate	0.5
Neubourg Silica	50
70% Non-Crystallizable Liquid Sorbitol	312.5
Anhydrous Disodium Hydrogen Phosphate	1.25
Colloidal Silica Hydrate (Tixosil 73)	135
Colloidal Silica Hydrate (Tixosil 43)	115
Mint Compound Essence	15.95
Purified Water	509.612
Total	1250

Source: Saidal intern document.

SAIDAL has allocated two rooms for its production:

-*Manufacturing room:* The raw materials are mixed together to create the toothpaste paste. Then, the paste is transferred to the conditioning room.

-*Conditioning room*: In this room, the toothpaste undergoes a transformation from a paste into a packaged product.

2.2.1. Manufacturing room:

- **Manufacturing instructions:** a batch of 1250 kg of paste form is going to be produced.

- **Manufacturing equipment**:

- Manufacturing equipment used in the production process includes a range of specialized tanks and pumps to ensure efficient and high-quality output. The **manufacturing tank** utilized is the **FRYMAVME 1300ML**, known for its precision and reliability. For storage, there is a general **storage tank** alongside two **600L storage tanks**, providing ample capacity for raw materials and finished products. Additionally, a **Pope type PK-115 FRYMA 3L** tank is employed for specific applications. The setup also incorporates a **FRYMA vacuum pump** and a **FRYMA transfer pump**, which are critical for maintaining product integrity during the manufacturing process.

- **Manufacturing steps :**

Step 01:Preparations: - Cleanliness check, labelling, gloves.

Step 02: Filling with purified water + Sobitol.

Step 03: Preparing the paste:

- First Mixture:

Introduce the ingredients "Sodium Monofluorophosphate (active ingredient), Sodium Fluoride (active ingredient), Sodium Benzoate, Sodium Hexametaphosphate, Simple Nipagine, Sodium Saccharinate, Hydrogeno Phosphate Disodique Anhydre" successively, then switch on the scraper and disperser, and mix for 15 minutes.

- Second Mixture:

Add Sodium Carraghenate and Titan Dioxide, then stir for 10 minutes.

- Final Mixture:

Add Tixosil 73, Tixosil 43 and Silice De Neubourg, then stir for 10 minutes.

Finally, add Lauryl Sodium Sulfate, mint essence and stir for 30 minutes.

Step 04: Deaeration of the paste.

Step 05: Sampling:

Draw up, record and transmit the request for physio-chemical analysis to the quality control lab.

Step06: Transfer and storage on the storage tank as soon as the release is received.

2.2.2. Conditioning room:

a- Packaging materials : The packaging process is supported by a variety of specialized equipment designed to streamline and enhance efficiency. The **packaging line feeder**, specifically the **IWKATZK 200**, ensures a steady and precise feed of materials into the packaging line. Within the **tube house**, there are integrated systems for **the hopper, filling, scooping, printing, and transferring**, all working in unison to handle tubes from start to finish. Additionally, a **house cartoner** is employed to automate the cartoning process, ensuring that products are securely packaged and ready for distribution.

b- Primary packaging: involves the meticulous distribution of the paste into varnished tubes. This process is executed on the IWKATZK 200 packaging line filler, where the paste is dispensed at a rate of 100 grams per tube. To ensure quality and consistency, several verification steps are undertaken, including checking the line vacuum, conformity, and batch number. Additionally, each tube's unit weight is carefully monitored to fall within the specified range of 97 grams to 103 grams, ensuring uniformity and adherence to standards.

c- *Secondary packaging :* is tailored for presenting the product in **100g tubes**, which are placed in **cardboard boxes** that display the batch number, date of manufacture, and expiration date. These boxes are then grouped into packs of **80** within a larger cardboard case. Following packaging, an analysis request is drawn up, signed, recorded, and forwarded to the **quality control laboratory** to ensure all products meet the required standards before distribution.

d- *Packaging yield "R" :* measures the efficiency of the packaging process. It is calculated using the formula:

95%≤R≤102%

R= (Quantity delivered to warehouse / Quantity scheduled (UV)) *100

The yield should fall within the range of 95% to 102%, indicating that the quantity delivered to the warehouse should be between 95% and 102% of the quantity initially scheduled. This ensures that packaging processes are efficient and product losses are minimal.

3. Causes of NATRI toothpaste waste:

NATRI aluminum tubes arrive from the supplier in a nested configuration: each tube is inserted into another, with the lids sealed, and positioned upside down. This compact arrangement ensures efficient use of space

3.1. First type of waste :*Empty tube.*

During the production launch, a machine trial run is conducted to ensure proper operation. One common type of waste identified is the empty tube. When operators place these empty tubes in the tube storage hopper, they can become damaged by being stacked on top of each other. Additionally, when empty tubes are placed in slots to be filled, the tube filler can damage the quality of the aluminum tubes.

3.2. Second waste type : *Filled tube waste.*

This issue stems from several factors: firstly, the poor quality of tubes of the supplier. These tubes frequently suffer from overfilling or underfilling, falling within Saidal's weight tolerance of +/- 3 grams, where a tube can weigh up to 103 grams or as little as 97 grams without being categorized as waste. Secondly, our filling machine consistently fails to fold the tubes properly post-filling. Additionally, during the quality check phase before packing into cartons, our operators inadvertently damage the tubes. Addressing these challenges is critical to maintaining efficiency and upholding our product standards.

3.3. Third type of waste*: Packaging*

This includes two main issues: firstly, our packaging machines are failing to fold the packaging correctly. Secondly, finding cuts in the packaging that render it unusable and therefore categorized as waste.

- Whenever any of this happens a waste record is written:

A waste record is a document that details the type of waste generated, whether it is product waste ("Machine adjustment, losses during calibration, vacuum cleaner waste, CPS waste") or

packaging waste ("Raw material packaging: Cartons/Drums/Bags, Finished product packaging: (Paper: cases/instructions/label/bottle/carton/sticker) or Glass: Bottles or Aluminum or PVC"). The waste record also includes the department or workshop generating the waste, the product designation, the quantity of waste, and any observations. This record is signed by the "line manager, department head, and stock management follow-up officer.

Section 02: Presentation of the field research methodology

In this section, we will introduce the various research methods employed in this study, including qualitative and quantitative approaches, as well as documentary research. These methods were carefully selected to ensure a comprehensive and rigorous investigation of the research topic.

1. The differences between quantitative and qualitative research:[18]

Table 10: Comparison of Qualitative and Quantitative Research Methods.

	Qualitative Research	Quantitative Research
Focus	Exploring ideas or formulating hypotheses/theories.	Testing hypotheses or theories.
Analysis	Summarizing, categorizing, interpreting.	Math and statistical analysis.
Expressed in	Words.	Numbers, graphs, tables, fewer words.
Sample	Few respondents.	Many respondents.
Questions	Open-ended.	Close-ended or multiple choice.
Characterized by	Understanding,context, complexity,subjectivity.	Testing, measurement, objectivity, replicability.
Data collection methods	- Interviews: Asking open-ended questions verbally to respondents. - Focus groups: Discussion among a group of people about a topic to gather opinions that can be used for further research. - Ethnography: Participating in a community or organization for an extended period of time to closely observe culture and behavior. - Literature review: Survey of published works by other authors.	- Surveys: List of closed or multiple choice questions that is distributed to a sample (online, in person, or over the phone). - Experiments: Situation in which different types of variables are controlled and manipulated to establish cause-and-effect relationships. - Observations: Observing subjects in a natural environment where variables can't be controlled.
Data analysis	Qualitative data is more difficult to analyze than quantitative data. It consists of text, images or videos instead of numbers.	Quantitative data is based on numbers. Simple math or more advanced statistical analysis is used to discover commonalities or patterns in the data. The results are often reported in graphs and tables.

Source : Qualitative vs. Quantitative Research | Differences, Examples & Methods (scribbr.com) », Consulted on 09/06/20 (STREEFKERK, 2019)24, at 22:14.

[18] « Qualitative vs. Quantitative Research | Differences, Examples & Methods (scribbr.com) », Consulted on 09/06/20 (STREEFKERK, 2019)24, at 22:14.

2. Methods used for the research:

To test my hypotheses in the field during my internship at SAIDAL Dar El Baida, I used qualitative research methods through interviews and mixed methods documentary research.

2.1.The interview:

2.1.1. Definition:

According to Cambridge dictionary *"To interview is also to ask questions of someone to get information."*[19]

Sewell (n.d) defines interviews in qualitative research as *"attempts to understand the world from the subject's point of view, to unfold the meaning of peoples' experiences, to uncover their lived world before scientific explanations."*[20]

2.1.2. Types of interviews:[21]

There are three types of interviews: structured, semi structured and unstructured interview.

- Structured Interview

Analysts recognize that all qualitative interviews have some structure (Jamshed, 2014), but structured interviews are particularly rigid. The interviewer fully controls the process, leaving little flexibility for the interviewee (Stuckey, 2013). These interviews resemble job interviews, with brief questions and expected concise responses.

The structured format can create a tense environment, making participants uneasy and prone to giving superficial answers. Researchers must strictly follow the sequence and wording of questions, without interpretation or improvisation (Stuckey, 2013). Participants cannot answer each other's questions, and the interviewer must not suggest answers.

Due to this rigidity, structured interviews are often viewed unfavorably in qualitative research (DiCicco-Bloom & Crabtree, 2006). While they ensure validity, bias prevention, and reliability, they may make participants uncomfortable and hinder the provision of necessary context. Consequently, structured interviews are better suited for quantitative data collection.

- Semi-Structured Interviews

Semi-structured interviews are the most commonly used in qualitative research (Alshenqeeti, 2014). They involve prepared topics and questions but allow flexibility based on

[19] "https://dictionary.cambridge.org/dictionary/english/interview ", Consulted on (Dictionary, 2024)09/06/2024 at 23:19.

[20] **ADHABI Essa, & BLASH ANOZIE Christina ; Literature Re** (Essa & Christina, 2017)**view for the Type of Interview in Qualitative Research;** Published September 17th,2017;Page05.

[21] **ADHABI Essa, & BLASH ANOZIE Christina ;** op;cit, page "08-14 ».

interviewee responses (Stuckey, 2013). Unlike structured interviews, they adapt to how the interviewee addresses the topics.

Researchers present topics for comfortable exploration by interviewees and can ask follow-up questions, enhancing inquiry depth. These interviews are essential sources of information in qualitative research (DiCicco-Bloom & Crabtree, 2006).

They can be conducted individually or in groups. Individual interviews allow for in-depth exploration, ideal for biographical research, while group interviews provide time to thoroughly explore subjects. Selecting interviewees should ensure relevance to the study question (DiCicco-Bloom & Crabtree, 2006).

Due to their flexibility and depth, semi-structured interviews are ideal for qualitative studies.

- Unstructured Interviews

While no interview is entirely unstructured, some are sufficiently disjointed to earn the label. Rooted in ethnographic traditions (DiCicco-Bloom & Crabtree, 2006), these interviews involve researchers immersing themselves in the environment, observing, identifying key subjects, and informally questioning them.

Viewed as narrative interviews (Stuckey, 2013), unstructured interviews are controlled conversations guided by the researcher. Subtypes include non-directive interviews, which lack pre-planned questions, and focused interviews, which guide subjects toward relevant topics (Jamshed, 2014).

Despite their irregular structure, unstructured interviews are a significant qualitative data collection tool.

2.2.Documentary research:

2.2.1. Definition:[22]

Documentary research method refers to the analysis of documents that contain information about the phenomenon we wish to study. The documentary research method is used in investigating and categorizing physical sources, most commonly written documents, whether in the private or public domain.

[22] AHMED Jashim Uddin ; "Documentary Research Method: New Dimensions"; I (Uddin, 2010)ndus Journal of Management & Social Science (IJMSS), Department of Business Administration, vol. 4(1), June 6th; 2010, pages 1-14.

Starting from a known research topic, documentary research involves searching for and identifying documents from reliable sources. The gathered information will be useful for expanding one's knowledge on the studied subject[23]

3. Reasons behind choosing these methods of research:

- Information about NATRI toothpaste waste are only available in documents of SAIDAL itself.

- Answers about improving and minimizing waste weren't available in any document, only specific workers had the information.

4. The conduct of the interviews:

4.1.People interviewed:

To achieve the objective of testing my hypotheses, I selected four workers who are directly involved with the product and its details: the Head of Equipment Management Department, the Production Line Supervisor, theDeputy Director of Procurement and Supply and Environmental delegate.

The selection of these managers was carefully considered based on several criteria. Firstly, it was essential to choose a small sample of individuals with extensive experience and deep knowledge of the company, which is vital for conducting qualitative research effectively. Secondly, the managers selected play a pivotal role in making numerous decisions within the management structure. Lastly, the chosen managers are recognized as reliable sources of valuable information, ensuring the research outcomes are grounded in credible insights and perspectives.

4.2.Interview Process :

The interview i conducted consisted of three stages:

- First stage: Scheduling appointments with the interviewees.
- Second stage: Questioning the interviewees.
- Third stage: Synthesizing the results.

[23] « Recherche documentaire : définition, types, méthodologie et exemple (scribbr.fr) » ; Consulted on 10/06/2024, at 02 :51. (DEBRET, 2018)

4.2.1. Scheduling appointments with the interviewees:

During my internship in SAIDAL, I fixed two days to perform these four interviews, on Wednesday, May 17th, 2024 and on Tuesday, June 04th,2024.

- Wednesday, May 17th,2024:
- 09AM: BOURHILA Nora: Deputy Director of Procurement and Supply.
- 10:30AM: BOUANIKA Mohamed Lamine: Production Line Supervisor.
- 11AM: KORCHI Belkacem: Head of Equipment Management Department.
- Tuesday, June 04th,2024:
- 10:47AM:BOUZIANI Safia: Environmental delegate.

4.2.2. Questioning the interviewees:

All of my questions pertained to SAIDAL studies aimed at minimizing NATRI toothpaste waste and determining the amount of waste generated by operators during the production process.

On Wednesday, May 17th, 2024:

At 9 AM, I made my way to the office of BOURHILA Nora to conduct the scheduled interview. It took 30 minutes to get all the answers to my questions.

Afterward, I waited until the time for my next interview arrived, then proceeded to the pharmaceutical manufacturing plant of SAIDAL to interview BOUANIKE Mohamed Lamine, the production line supervisor. It also took him exactly 30 minutes to answer all the questions.

Finally, I interviewed KORCHI Belkacem, Head of the Equipment Management Department, and had a 30-minute interview with him, he explained to me the process of buying a new machine “FAT: trying the machine at the supplier’s place, IQ: installing the machine at the client’s place, OQ: testing the different machine parts individually, SAT: testing the whole machine all at once)

On Tuesday, June 4th, 2024:

I interviewed my last interviewee at 10:47 AM, BOUZIANI Safia, the Environmental delegate. The interview took exactly one hour, as we both discussed my hypothesis about improving waste management concerning NATRI toothpaste at SAIDAL.

a- BOURHILA Nora: Deputy Director of Procurement and Supply:

Q1:Are the aluminum tubes a local product or imported?

A1:*Imported only, from a French supplier "Saszi ducked Bonnet et Boulevard Jean Moulin BP 182 49412 SAUMUR Cudex.*

Q2:Have you considered changing the aluminum tubes supplier to another one one who can offer a better quality?

A2*:Yes, but alternatives were only available from a Spanish supplier, and with Algeria halting imports from Spain, efforts have focused on the new machine.*

Q3: Is the price difference the reason for not switching supplier ? or there's another reason?

A3:*No , the price difference was never the reason , but the type of these tubes is the reason.*

b- BOUANIKA Mohamed Lamine: Production Line Supervisor:

Q1:How much waste do operators make for each type of NATRI toothpaste waste?

A1:-*Filled tubes≈ 07.*

-Empty tubes≈07.

-Packagings≈ 07.

Q2:Have you considered training, retraining or changing operators? And what is the criteria for selecting them?

A2:*No, all we did is try to teach them how to work properly, changing operators only happens in extreme cases which never happened before in SAIDAL. Choosing operators depends on work experience only, no formal diploma.*

Q3:Since NATRI toothpaste production machine is old, its parts are no longer available in the market which causes more waste, how do you cooperate with it and what do you propose?

A3:*I patch up with available ressources but if it takes more than 15 minutes I fill a repair request to the machinist, or fill a complaint to the administration but it takes so long to get a response.*

-The part of the machine with the most problems is the tubing system filler , as it has missing parts that affect the machine negatively by making it damage tubes while closing them.

c- KORCHI Belkacem: Head of Equipment Management Department:

Q1:When did SAIDAL buy the new machine "CAM-SAV"? and what are its components?

A1:*Since 02 years from an Italian supplier.*

-Machine Components: Tube housing , cartoner , labeler, sorter , case packer.

Q2:How long has it been since the machine malfunctioned? And how long has it been since then?

A2:*The machine didn't actually break down; the "sorter" is not functioning.*

-During FAT in Italy, it only produced 60 tubes due to the lack of an air compressor. Saidal bought it assuming their own compressor would suffice, but now they are stuck at OQ as the sorter isn't working.

Q3: What is the production capacity of the new machine?

A3:*NATRI toothpaste: 120 tubes as per the specifications*

50g tube (children)

100g tube

(Capacity: 10-20-40-50-100 grams)

d- BOUZIANI Safia: Environmental delegate:

Q1:What are the data and steps involved in the treatment of NATRI toothpaste waste?

A1:

A. Waste record (filled tubes)

B. Purchase request/order form for incineration services

C. When the company responsible for handling the waste of filled tubes arrives, they bring a removal receipt that contains all the necessary information (Incinerators are always state-approved to prevent environmental pollution).

Q2:Have they conducted studies on waste to improve it?If yes, what are the studies?If not, why have no studies been conducted?

A2:*No, they have not. I tried to raise awareness, but they did not implement any measures.*

Q3:Have they considered recycling? Yes or no, and why?

A3:*•We only recycle empty tubes and cases, but we incinerate filled tubes because, once filled, they become contaminated. We tried to empty the tubes so that the product wouldn't go to waste, but according to the laboratory, the recycled product was non-compliant/contaminated.*

•Packaging: packaging waste is taken by the company Gipec (state-owned company).

•Empty tubes and cases are sold to eco-friendly companies.

Filled tubes: Incineration report under conditions that do not negatively impact the environment (incineration owner + bailiff).

4.2.3. Synthesizing the results:

To have a better view concerning the results of these interviews, after transforming all my interviewee answers into my notes, the obtained results were followed by comments in order to facilitate a synthesis that will enable us to materialize our project.

- **BOURHILA Nora: Deputy Director of Procurement and Supply:**

The interview responses reveal that the company imports aluminum tubes exclusively from a French supplier due to specific quality or type requirements, with no local production available. Although they considered switching to a Spanish supplier to improve quality, geopolitical issues—specifically Algeria halting imports from Spain—prevented this change. Consequently, the company focused on upgrading their machinery to address quality concerns. The decision not to switch suppliers was not cost-related but driven by the necessity of a specific tube type, highlighting the company's strategic approach to maintaining product standards through internal improvements despite external supply chain constraints.

- **BOUANIKA Mohamed Lamine: Production Line Supervisor:**

The interview highlights several critical issues in the production process. Operators produce equal amounts of waste across filled tubes, empty tubes, and cases, indicating a consistent waste problem. They receive only basic training, which may contribute to inefficiencies, and replacement of operators is considered only in extreme cases, which has never occurred. Operator selection is based solely on work experience without formal education requirements, possibly affecting skill levels. To mitigate machine waste amidst part unavailability, the company resorts to patching up with available resources and filing complaints to administration, although responses are slow. Major issues include prolonged

machine adjustments and frequent tubing system problems, such as missing parts and tube damage during filling and sealing, pointing to both operational and maintenance challenges.

- **KORCHI Belkacem: Head of Equipment Management Department:**

The interview reveals that SAIDAL purchased the new "CAM-SAV" machine from an Italian supplier two years ago. The machine consists of several components: a tube housing, cartoner, labeler, sorter, and case packer. Although the machine has not experienced a complete breakdown, the sorter component is non-functional. During the Factory Acceptance Test (FAT) in Italy, the machine produced only 60 tubes due to the absence of an air compressor. SAIDAL assumed their own compressor would be adequate, but now they are stuck at the Operational Qualification (OQ) stage due to the sorter issue. The production capacity of the machine is specified at 120 tubes for Natri, with various tube sizes (10, 20, 40, 50, and 100 grams), including 50g tubes for children and 100g tubes. This indicates that the machine's potential is currently hindered by equipment compatibility issues.

- **BOUZIANI Safia: Environmental delegate:**

The interview outlines the process and challenges in managing NATRI toothpaste waste at SAIDAL. Waste is documented in a waste record, and incineration services are requested through purchase orders. When the incineration company arrives, they bring a detailed removal receipt, ensuring state-approved incinerators are used to prevent pollution. Despite attempts to raise awareness, no significant measures have been implemented to study or improve waste management. Recycling efforts are limited to empty tubes and cases, as filled tubes are incinerated due to contamination risks. Efforts to recycle filled tubes failed, as the laboratory deemed the product non-compliant. Waste during manufacturing includes a loss of 6-7 kg of paste. Packaging waste, such as cases, is handled by the state-owned company Gipec, and both empty tubes and cases are sold to eco-friendly companies. This indicates a need for better training and more effective waste management strategies.

4.3.Synthesis of Interviews on NATRI Toothpaste Production and Waste Management at SAIDAL

The interviews conducted at SAIDAL provide a detailed look into the company's efforts and struggles with producing NATRI toothpaste and managing waste.

Supply Chain and Machine Issues:

- SAIDAL imports aluminum tubes from a French supplier because local options aren't available and geopolitical issues prevent sourcing from Spain. This dependency on a single supplier adds some risk to their operations.
- They bought a new machine, the "CAM-SAV," from Italy two years ago. Unfortunately, the sorter part of the machine isn't working. This issue stems from a misunderstanding about the air compressor compatibility during testing in Italy. Despite these setbacks, the machine is capable of producing various sizes of toothpaste tubes, but its potential is currently limited.
-

Waste Management:

- Waste is carefully tracked using waste records, and incineration services are arranged through purchase requests. They ensure that incineration is done at state-approved facilities to avoid harming the environment.
- Although there have been efforts to raise awareness about waste reduction, there haven't been significant improvements or new measures implemented.
- Recycling efforts are somewhat constrained. They recycle empty tubes and cases, but filled tubes are incinerated due to contamination concerns. Attempts to recycle filled tubes were unsuccessful as the lab found the product to be non-compliant.

Operator Training and Efficiency:

- Operators produce consistent levels of waste across different categories (filled tubes, empty tubes, and cases). They receive only basic training, which likely contributes to inefficiencies.
- Changing operators is a last resort and hasn't been necessary so far. Operators are chosen based on their work experience, without formal educational requirements.

Manufacturing Challenges:

- The production process sees significant waste, including a loss of 6-7 kg of paste each time they manufacture.
- Packaging waste is managed by a state-owned company, Gipec. Empty tubes and cases are sold to eco-friendly companies, showing some commitment to sustainability.

4.4.Recommendations:

- **Strengthen Training Programs:** Enhance training programs for operators to improve efficiency and reduce waste generation. Providing comprehensive training sessions, including practical exercises and ongoing education on waste reduction techniques, could significantly enhance operator skills and contribute to a more sustainable production process.

- **Implement Proactive Waste Reduction Measures:** Develop and implement proactive waste reduction measures by conducting thorough studies to identify areas where waste can be minimized. Engage employees at all levels in waste reduction initiatives, fostering a culture of continuous improvement and sustainability throughout the organization.
- **Diversify Supply Chain and Procurement Strategy:** Explore alternative suppliers and diversify the supply chain to mitigate risks associated with dependency on a single supplier. Prioritize suppliers with reliable quality and delivery records while considering geopolitical factors to ensure a more resilient supply chain.
- **Enhance Machinery and Technology:** Invest in upgrading machinery and technology to improve efficiency and address technical challenges. Conduct comprehensive compatibility tests during procurement to avoid issues like those experienced with the "CAM-SAV" machine. Regular maintenance and monitoring of equipment performance are also crucial to prevent breakdowns and optimize production.
- **Foster Collaboration and Innovation:** Encourage collaboration between different departments and teams to identify innovative solutions for waste reduction and process optimization. Establish a platform for sharing best practices and lessons learned to drive continuous improvement across all aspects of production and waste management.
- **Strengthen Environmental Compliance:** Ensure strict adherence to environmental regulations and standards in waste management practices. Regular audits and assessments should be conducted to monitor compliance and identify areas for improvement. Strengthen partnerships with state-approved waste disposal facilities to ensure safe and environmentally responsible waste disposal practices.
- **Invest in Research and Development:** Allocate resources for research and development efforts aimed at finding sustainable alternatives for waste management and product packaging. Invest in technology and innovation that promotes circular economy principles, such as recyclable or biodegradable packaging materials.

In summary, while SAIDAL has laid down the basics for waste management and production, there's a lot they could do to improve. Better training, proactive waste reduction,

and resolving technical issues are key areas they need to focus on to enhance their operations and sustainability efforts.

5. The conduct of the documentary research:

5.1.The documents used:

In every production operation of NATRI toothpaste, there is inevitably waste, which is documented on a sheet called the 'waste record.' This record contains details such as the date, type, quantity, and is signed by managers.

5.2.Documentary research process:

The process of this research can be described in three 03 steps:

- Step one: Getting all the waste records available in SAIDAL about NATRI toothpaste and writing all the information in the documents in a table that contains the year, the month, number of batches produced, waste in kilograms of every type “Empty tubes, filled tubes, cases”.
- Step two: Transforming from kilograms to number of empty/filled tubes and cases.
- Step three: Synthesizing the results.

5.2.1. NATRI toothpaste waste:

Table 11: NATRI toothpaste waste and its profit loss in 2021.

Year	Month	Production	Packaging Waste	Empty tube waste	Filled tube waste	Total waste cost
2021	January	400 000	600	8 500		
2021	March	225 000	141	4 350	1 867	
2021	April	562 500	111	4 820	858	
TOTAL WASTE			852	17 670	2 725	
Loss(DZD)			306,8	4 160,2	342 914	347 381

Source : SAIDAL INTERN DOCUMENT

The table presents production data for January, March, and April 2021 during the pandemic of COVID-19 where SAIDAL had to pause production at April which is because their tubes were imported but during that period it was impossible to get that done, highlighting packaging waste, empty tube waste, filled tube waste, and total waste costs. Notably, filled tube

waste incurs the highest loss at 342,914 DZD, underscoring the need for advanced filling machinery and stringent quality control measures. Empty tube waste also contributes significantly to losses at 4,160.2 DZD, suggesting that implementing data analytics and automation could mitigate this issue. Although packaging waste is lower at 306.8 DZD, it still impacts overall waste and can be further reduced through sustainable materials and recycling programs. To improve waste management, it is recommended to adopt rigorous SOPs, lean manufacturing practices, and continuous performance monitoring, alongside employee involvement in identifying inefficiencies. These measures will help reduce waste, lower costs, and enhance production efficiency and sustainability.

Table 12: NATRI toothpaste waste and its profit loss in 2022.

Year	**Month**	**Production**	**Packaging Waste**	**Empty tube waste**	**Filled tube waste**	**Total waste**
2022	Fabruary	250 000	950	4 500	570	
2022	March	562 500	468	20 710	1 496	
2022	April	112 500	69	3 580	490	
2022	June		273	2 050		
2022	December	587 500	706	15 360	2 091	
TOTAL WASTE			2 466	46 200	4 647	
Loss(DAZD)			887,8	10 877,3	584 778.48	586 477.58

Source : SAIDAL INTERN DOCUMENT

The table for 2022 provides data on production, packaging waste, empty tube waste, filled tube waste, and total waste across five months. The most significant waste contributor is filled tube waste, leading to a substantial loss of 584,778.48 DZD, indicating a need for enhanced filling machinery and stricter quality controls. Empty tube waste, with a loss of 10,877.3 DZD, suggests the need for better data analytics and automation to reduce this waste. Packaging waste, while lower in impact at 887.8 DZD, still requires attention through sustainable packaging and recycling efforts. Overall, the aggregated data shows high total waste, emphasizing the importance of implementing rigorous SOPs, lean manufacturing practices, and continuous

performance monitoring. By involving employees in waste reduction initiatives and focusing on advanced technologies, the company can significantly reduce waste and associated costs, improving efficiency and sustainability.

Table 13: NATRI toothpaste waste and its profit loss in 2023.

Year	Month	Production	Packaging Waste	Empty tube waste	Filled tube waste	Total waste
2023	January		225	2 510	953	
2023	February	300 000	709	8 120	1 902	
2023	March	450 000	2125	15 530	1 876	
2023	April	237 500	1 270	8 300	1 460	
2023	Mai	925 000	3 040	36 060	3 945	
2023	June	300 000	1 490	18 900	673	
2023	Jully	125 000	552	3 240	170	
2023	August	237 500	285	1 300	1 300	
2023	September	162 500	1 105	4 250	1 514	
2023	October	137 500	1 173	5 230	1 925	
2023	November	487 500	600	11 800	1 310	
2023	December	100 000	100	100		
TOTAL WASTE			1 2674	115 340	1 7028	
Loss(DZD)			4 526,64	27 155,6	2142803.52	2 174 485.76

Source: SAIDAL internal document

The table for 2023 shows data on production, packaging waste, empty tube waste, filled tube waste, and total waste for each month. Filled tube waste is the most significant contributor, resulting in a substantial loss of 2,142,803.52 DZD, highlighting the urgent need for advanced filling machinery and stringent quality control measures to mitigate these losses. Empty tube waste, with a loss of 27,155.6 DZD, indicates the importance of improved data analytics and automation to minimize this waste. Although packaging waste accounts for a smaller portion of the total loss at 4,526.64 DZD, it still impacts overall waste management and can be addressed through sustainable packaging solutions and recycling programs. The high total waste for 2023 underscores the necessity for implementing rigorous SOPs, lean manufacturing practices, and continuous performance monitoring. Engaging employees in identifying

inefficiencies and incorporating advanced technologies can significantly reduce waste and associated costs, thereby enhancing overall production efficiency and sustainability.

Table 14: NATRI toothpaste waste and its profit loss in the first half of 2024.

Year	Month	Production	Packaging Waste	Empty tube waste	Filled tube waste	Total waste
2024	January	512 500	720	3 100	615	
2024	Fberuary	425 000	580	2 300	3 340	
2024	March	275 000	503	10 060	3 506	
2024	April	312 500	1 535	4 200	3 960	
2024	May	512 500	2 370	280	2 400	
TOTAL			5 708	19 940	13 821	
Loss(DZD)			2 054,9	5 288	1 739 234.64	1746580.54

Source: SAIDAL internal document

The table for 2024 provides production data alongside packaging waste, empty tube waste, filled tube waste, and total waste for the first five months. The filled tube waste remains the highest contributor to losses, with a significant impact of 1,739,234.64 DZD, stressing the need for advanced filling machinery and enhanced quality controls. Empty tube waste, causing a loss of 5,288 DZD, suggests a continued need for improved data analytics and automation. Packaging waste, though lower in impact at 2,054.9 DZD, still requires attention through sustainable packaging solutions and recycling programs. The aggregated data indicates high total waste, emphasizing the importance of implementing rigorous SOPs, lean manufacturing practices, and continuous performance monitoring. By involving employees in identifying inefficiencies and incorporating advanced technologies, the company can effectively reduce waste and associated costs, improving production efficiency and sustainability.

Table 15: NATRI toothpaste profit loss in the previous four years (2021-2024).

Year	Packaging profit loss (DZD)	Empty tube profit loss (DZD)	Filled tube profit loss (DZD)
2021	306,8	4 160,2	342 914
2022	887,8	10 877,3	584 778.48
2023	4 526,64	27 155,6	2 142 803.52
2024	2 054,9	5 288	1 739 234.64

Source: SAIDAL internal document

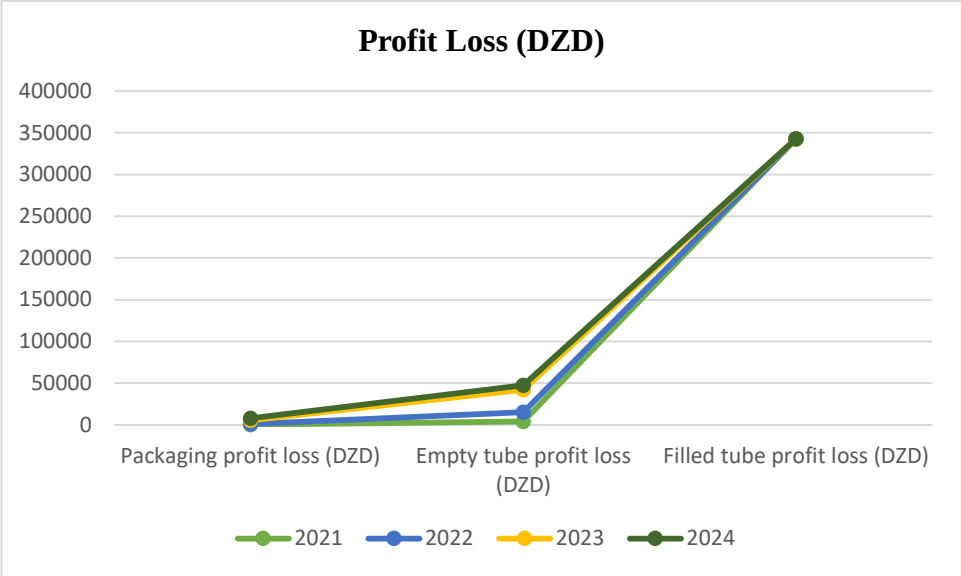

Figure 08: Line chart that compares the profit losses (in DZD) associated with three types of waste over four years (2021-2024).

The line chart above illustrates the profit loss (in DZD) for three types of waste—packaging, empty tubes, and filled tubes—over the four years from 2021 to 2024. The chart shows a significant increase in profit loss for all three waste types from 2023 to 2024, while the profit losses remain relatively stable from 2021 to 2023. Among the waste types, the filled tube profit loss exhibits the most substantial increase by 2024, distinguishing itself from packaging and empty tube profit losses, which follow similar trends but with lower values. In 2021, 2022, and 2023, the differences in profit losses between the three waste types are minimal; however, by 2024, filled tube profit loss is markedly higher.

Table 16:Rate of waste of the three types during the period of (2021-2024)

Year	**Packaging waste %**	**Empty tube waste %**	**Filled tube waste %**
2021	0,07	1,48	0,23
2022	0,16	3,05	0,3
2023	0,37	3,33	0,5
2024	0.28	0.97	0.67

Source: SAIDAL intern document

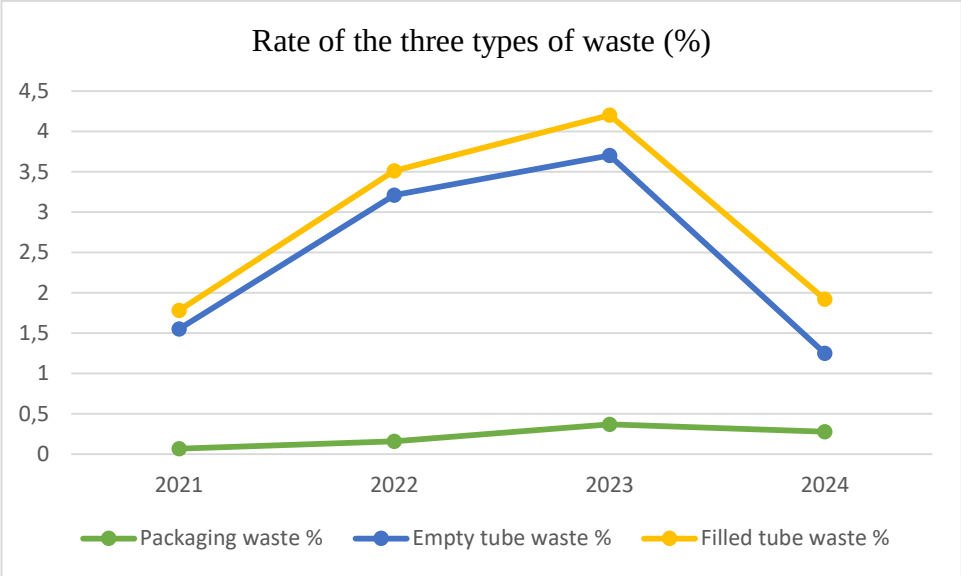

Figure 09: Line chart that compares the rates of the three types of waste (as percentages) over four years (2021-2024).

The line chart above illustrates the rates of three types of waste—packaging, empty tubes, and filled tubes—as percentages over the four years from 2021 to 2024. The data reveals distinct trends for each type of waste. The filled tube waste percentage sees a noticeable peak in 2023 before sharply declining in 2024. Similarly, the empty tube waste percentage increases until 2023 and then drops significantly in 2024. In contrast, the packaging waste percentage remains relatively stable throughout the period, showing only a slight increase over the years. The filled tube waste consistently has the highest rates compared to the other types, with empty tube waste following and packaging waste maintaining the lowest rate. This pattern suggests that while packaging waste remains a minor concern, both empty and filled tube wastes exhibit more significant fluctuations, particularly with a peak in 2023.

5.3.Synthesis of NATRI Toothpaste Waste and Production Analysis at SAIDAL

The analysis of NATRI toothpaste waste and production at SAIDAL reveals both challenges and opportunities for improvement. Despite missing data for 2021 and 2022, likely due to the COVID-19 pandemic, valuable insights can still be drawn from available information.

- **Empty Tube Waste**: Across the years, empty tube waste consistently emerged as the largest contributor to total waste. The highest spikes were observed in March 2022 and May 2023.

- **Filled Tube Waste**: While not as frequent, filled tube waste has a significant financial impact, accounting for the majority of financial losses each year. Improving the filling process could drastically reduce these costs.

- **Packaging Waste**: Although contributing less to overall waste, packaging waste still presents an area for potential savings and efficiency improvements.

- **Financial Losses**: The cumulative financial losses highlight a need for strategic interventions. The loss from filled tube waste alone exceeded 1.7 million DA in early 2024, emphasizing the critical need for process optimization.

5.4.Recommendations:

- **Process Optimization**

Quality Control Enhancements: Implement rigorous quality control protocols throughout the production line. Introduce automated inspection systems to detect defects early, preventing defective products from progressing through the production process.

Standard Operating Procedures (SOPs): Develop and standardize SOPs for every stage of production. Regularly train employees to ensure adherence to these procedures, minimizing human error and inefficiencies.

Lean Manufacturing Practices: Adopt lean manufacturing techniques to streamline operations, reduce waste, and improve overall efficiency. Techniques such as the 5S methodology (Sort, Set in order, Shine, Standardize, Sustain) can help in maintaining a clean and organized workspace, reducing errors and waste.

- **Technology Upgrades**

Advanced Filling Machinery: Invest in state-of-the-art filling machines that offer higher precision and consistency. These machines should be capable of minimizing overfills and underfills, thus reducing filled tube waste significantly.

Automation and Robotics: Integrate automation and robotics into the production process. Automated systems can handle repetitive tasks with higher accuracy and efficiency, reducing the likelihood of human-induced errors and inconsistencies.

Data Analytics: Implement data analytics tools to monitor production metrics in real-time. Analyzing this data can help identify patterns and areas of waste, enabling proactive measures to address issues promptly.

- **Waste Management Strategies**

Recycling and Reuse Programs: Establish programs for recycling packaging materials and reusing components where possible. Partner with recycling companies to ensure that waste is processed sustainably.

Supplier Collaboration: Work closely with suppliers to reduce packaging waste from the outset. Encourage suppliers to use sustainable materials and provide products in bulk to minimize packaging requirements.

Waste Segregation and Treatment: Develop a comprehensive waste segregation and treatment plan. Separate waste into categories (e.g., recyclable, non-recyclable, hazardous) and treat each category accordingly to reduce environmental impact.

- **Continuous Monitoring and Improvement**

Performance Metrics: Define key performance indicators (KPIs) related to production efficiency and waste reduction. Regularly review these metrics to gauge progress and identify areas needing improvement.

Root Cause Analysis: When waste or inefficiencies are identified, conduct thorough root cause analyses to determine underlying issues. Address these issues systematically to prevent recurrence.

Employee Involvement: Foster a culture of continuous improvement by involving employees in identifying inefficiencies and suggesting improvements. Implement suggestion schemes and reward systems to motivate staff participation.

- **Sustainable Practices**

Eco-Friendly Materials: Explore the use of biodegradable or eco-friendly materials for packaging and production. This shift can reduce the environmental impact and appeal to environmentally conscious consumers.

Energy Efficiency: Invest in energy-efficient machinery and lighting to reduce the carbon footprint of the production process. Regularly audit energy usage and implement measures to improve efficiency.

- **Financial Management**

Cost-Benefit Analysis: Perform detailed cost-benefit analyses for proposed improvements. This analysis should consider both the short-term investments required and the long-term savings and efficiencies gained.

Budget Allocation: Allocate sufficient budget for upgrading technology, training staff, and implementing waste reduction initiatives. Prioritize investments that offer the highest return on investment in terms of waste reduction and efficiency gains.

Financial Incentives: Explore financial incentives such as grants or tax benefits for implementing sustainable practices and reducing waste. These incentives can help offset the initial costs of improvements.

- ## Conclusion:

In conclusion, the synthesis of both the interviews and the table analysis provides valuable insights into SAIDAL's operations regarding NATRI toothpaste production and waste management. The interviews shed light on various aspects, including waste treatment procedures, operator training, machine components, and challenges faced in waste reduction efforts. Meanwhile, the table analysis allowed us to track waste trends and production dynamics over the past four years.

Combining these perspectives, it's evident that SAIDAL faces both challenges and opportunities in waste management. While efforts to reduce waste and improve production efficiency are underway, there are areas that require attention, such as supply chain resilience, quality control, and employee training.

Moving forward, it's essential for SAIDAL to implement comprehensive strategies aimed at optimizing production processes, reducing waste generation, and enhancing profitability while promoting environmental sustainability. By addressing the identified issues and implementing the recommended measures, SAIDAL can position itself for long-term success in waste management and production efficiency.

Section 03: Presentation of the Study Results in SAIDAL about NATRI toothpaste:

In this last section and according to the previous studies I made with SAIDAL about NATRI toothpaste, a final synthesis and recommendation will be written to conclude the study and test the hypothesis.

1. Synthesis of Study Results: SAIDAL's NATRI Toothpaste Production and Waste Management:

The study conducted at SAIDAL aimed to provide a thorough analysis of the production processes and waste management practices associated with NATRI toothpaste. Through a combination of in-depth interviews with key personnel and meticulous analysis of production data, a comprehensive overview of SAIDAL's operations regarding NATRI toothpaste emerged, highlighting both challenges and opportunities.

During the interviews, several key findings were uncovered. It was revealed that waste generated during NATRI toothpaste production is primarily managed through incineration, with detailed waste records maintained to track the types, quantities, and disposal methods. Despite operators receiving basic training, they encounter challenges such as machine-related issues and packaging defects, which contribute to waste generation and impact production efficiency. The CAM-SAV machine, procured in 2022, experienced malfunctions, particularly with the sorter component, resulting in production disruptions and inefficiencies. Efforts to improve waste management practices, including raising awareness and implementing waste reduction strategies, have been made, but challenges in implementation persist, hindering significant progress in waste minimization.

Analysis of production data provided additional insights into production and waste trends. There were notable increases in production observed in 2024 compared to previous years, indicating potential growth or increased market demand. While there was a slight decrease observed in packaging waste, waste from filled tubes remained relatively consistent, indicating ongoing challenges in waste reduction efforts. Financial implications were evident, with a continuous decrease observed in packaging profit, while profits from waste generated by empty tubes showed a potential increase until 2024.

In summary, the synthesis of interview findings and production data analysis provides a comprehensive understanding of SAIDAL's NATRI toothpaste production and waste management practices. By implementing the recommended strategies, SAIDAL can optimize production efficiency, reduce waste generation, and improve profitability while fostering environmental sustainability in its operations.

2. Recommandations :

Based on the synthesis of interview findings and production data analysis, several comprehensive recommendations are proposed to enhance SAIDAL's NATRI toothpaste production and waste management practices:

1. **Enhance Operator Training Programs:** Develop comprehensive training programs to address machine-related issues and minimize packaging defects. Regular training sessions should focus on equipment operation, maintenance, and troubleshooting to improve operator competency and reduce waste generation.

2. **Prioritize CAM-SAV Machine Maintenance:** Allocate resources to promptly address malfunctions in the CAM-SAV machine, particularly with the sorter component. Implement preventive maintenance schedules and ensure timely repairs to optimize production efficiency and minimize downtime.

3. **Implement Robust Waste Management Strategies:** Strengthen waste management practices by raising awareness among employees and implementing effective waste reduction initiatives. Develop clear protocols for waste segregation, handling, and disposal to minimize environmental impact and improve resource efficiency.

4. **Invest in Sustainable Packaging Solutions:** Explore opportunities to invest in eco-friendly packaging materials that reduce environmental impact and promote recyclability. Collaborate with suppliers to source sustainable packaging options and minimize packaging waste throughout the production process.

5. **Enhance Quality Control Measures:** Implement stringent quality control measures to identify and rectify packaging defects, thus reducing waste generation and improving product quality. Regular quality audits should be conducted to ensure compliance with standards and regulations.

6. **Optimize Production Processes:** Continuously monitor and optimize production processes to minimize waste generation and improve efficiency. Invest in technology upgrades and automation where feasible to streamline operations and reduce human error.

7. **Strengthen Data Collection and Analysis:** Enhance data collection and analysis processes to track waste trends effectively. Implement robust reporting mechanisms to monitor key performance indicators related to waste generation, allowing for informed decision-making and continuous improvement.

8. **Promote Employee Engagement and Innovation:** Foster a culture of employee involvement and innovation by encouraging suggestions for waste reduction and process improvement. Implement reward and recognition programs to incentivize employee participation in waste reduction initiatives.

9. **Collaborate with Stakeholders:** Establish partnerships with waste management authorities, suppliers, and other stakeholders to exchange best practices and promote sustainability throughout the supply chain. Engage with local communities to raise awareness and foster support for waste reduction efforts.

10. **Commit to Continuous Improvement:** Embrace a philosophy of continuous improvement by regularly reviewing and updating waste management strategies and production processes. Monitor progress towards waste reduction goals and adapt strategies as needed to achieve long-term sustainability objectives.

11. **Evaluate Alternative Suppliers for Quality Improvement:** Conduct a thorough evaluation of alternative suppliers for packaging materials and machine components to ensure better quality and reliability. Explore options beyond current suppliers to identify those offering superior quality materials and components. Consider factors such as product quality, reliability, delivery times, and environmental sustainability practices when selecting suppliers. Collaborate closely with chosen suppliers to establish stringent quality control measures and ensure consistent quality standards are met throughout the production process. By partnering with reliable and quality-focused suppliers, SAIDAL can enhance product quality, minimize waste due to packaging defects, and improve overall efficiency.

By implementing these recommendations, SAIDAL can optimize production efficiency, reduce waste generation, and improve profitability while promoting environmental sustainability and social responsibility. These measures will position SAIDAL as a leader in sustainable manufacturing practices and contribute to a cleaner, greener future for all.

Conclusion:

The comprehensive analysis of SAIDAL's NATRI toothpaste production and waste management practices revealed both challenges and opportunities. Interviews highlighted issues such as operator training gaps and machine malfunctions, while production data showed trends in waste generation and financial impacts.

To address these challenges, several recommendations were proposed. Enhancing operator training, prioritizing machine maintenance, and implementing robust waste management strategies are crucial steps. Additionally, investing in sustainable packaging, strengthening quality control, and evaluating better suppliers will improve product quality and reduce waste.

Fostering employee engagement, collaborating with stakeholders, and committing to continuous improvement will ensure ongoing progress. By adopting these recommendations, SAIDAL can boost efficiency, reduce waste, and increase profitability, all while promoting environmental sustainability and social responsibility.

General Conclusion

This research aimed to study the impact of efficient waste management on corporate profitability, with a specific focus on the waste management practices of the NATRI toothpaste product. To achieve this, the study employed qualitative interviews and documentary research methods, ensuring a comprehensive approach to gather and analyze data.

The research began with a thorough exploration of different concepts related to waste management. This included defining waste management, understanding its principles, and categorizing various types of waste, with a particular emphasis on pharmaceutical waste. By gaining a solid foundation in these areas, the study set the stage for more detailed fieldwork.

My fieldwork was conducted at SAIDAL DAR EL BAIDA, where I had the opportunity to delve into the production unit. Here, I closely examined the production process of NATRI toothpaste, identifying the stages at which different types of waste were generated. This hands-on approach provided valuable insights into the practical aspects of waste production and management within the facility.

Following the field observations, I collected all available waste records from SAIDAL DAR EL BAIDA. These records were meticulously analyzed to identify trends and patterns in waste generation. Based on this analysis, I formulated and presented a series of recommendations aimed at improving waste management practices and enhancing corporate profitability.

To further enrich my research, I conducted interviews with various workers involved in the production of NATRI toothpaste. These interviews were essential in gathering firsthand information and insights. I spoke with four interviewees who had direct involvement with different aspects of the NATRI toothpaste production process. These interviews provided a deeper understanding of the challenges and opportunities related to waste management from the perspective of those working on the ground.

As with any production process, the manufacturing of NATRI toothpaste inevitably results in some waste. However, my analysis revealed that the amount of waste generated in this production was significant enough to be noteworthy. This was clearly illustrated in the table I created, which summarized the waste records over the past four years.

One of the initial observations I made was the poor quality of the tubes supplied by a French supplier. To confirm this hypothesis, I consulted with the deputy director of procurement and supply, who confirmed my suspicions. The deputy director explained that

although SAIDAL had made efforts to identify new suppliers for the NATRI toothpaste tubes, geopolitical issues prevented successful procurement, so the first hypothesis “Metal suppliers provide higher quality materials as a result of rigorous contracts” is confirmed.

Despite these challenges, and according to my research my second hypothesis is partly confirmed, which stated, "Machine adjustments in the conveyor ensure the integrity of the product’s packaging." While it is true that the old machine contributes to waste, it became evident that the primary issue lies with the tubing system. Given that parts for the old machine are no longer available, SAIDAL made the decision to invest in a new machine. This new equipment is designed to produce a variety of products and handle larger quantities, addressing some of the waste-related issues.

Additionally, according to the production line supervisor my third hypothesis is confirmed, which posited that high-skilled workers handle sensitive products with care. At SAIDAL, operators are hired based on their experience, rather than formal diplomas. This approach ensures that the products are handled by knowledgeable and experienced personnel, minimizing the risk of damage.

The final hypothesis, "Final waste is recycled instead of being incinerated," was only partly confirmed. While it is true that filled tubes are incinerated along with the paste due to contamination concerns, empty tubes and cases are indeed recycled. This recycling is carried out by an eco-friendly state-owned company, as verified by the environmental delegate.

According to this study and the confirmed hypotheses, I can address the research question: 'Which waste reduction areas have a positive impact on profit?'.

Several areas of waste reduction can positively impact profit:

1. **Machine Maintenance and Upgrades**: Investing in new machinery and addressing issues with the old equipment can significantly reduce waste from machine malfunctions. With a new machine that produces a variety of products more efficiently, there's less waste, which translates to lower costs and higher profits.

2. **Improving Supplier Quality**: Ensuring that the tubes come from high-quality suppliers can make a big difference. Better quality materials mean fewer defects and less waste during production, leading to cost savings and better profit margins.

3. **Operator Training**: Hiring experienced operators who handle products with care is crucial. When skilled workers manage the production process, there's less risk of damage and waste, which improves efficiency and boosts profits.

4. **Recycling Practices**: Implementing effective recycling for empty tubes and cases helps reduce the amount of waste that needs to be incinerated. This not only cuts down on disposal costs but also enhances the company’s reputation for sustainability, which can attract more customers and increase profitability.

By focusing on these areas, SAIDAL can cut down on waste and improve its bottom line, all while promoting more sustainable production practices.

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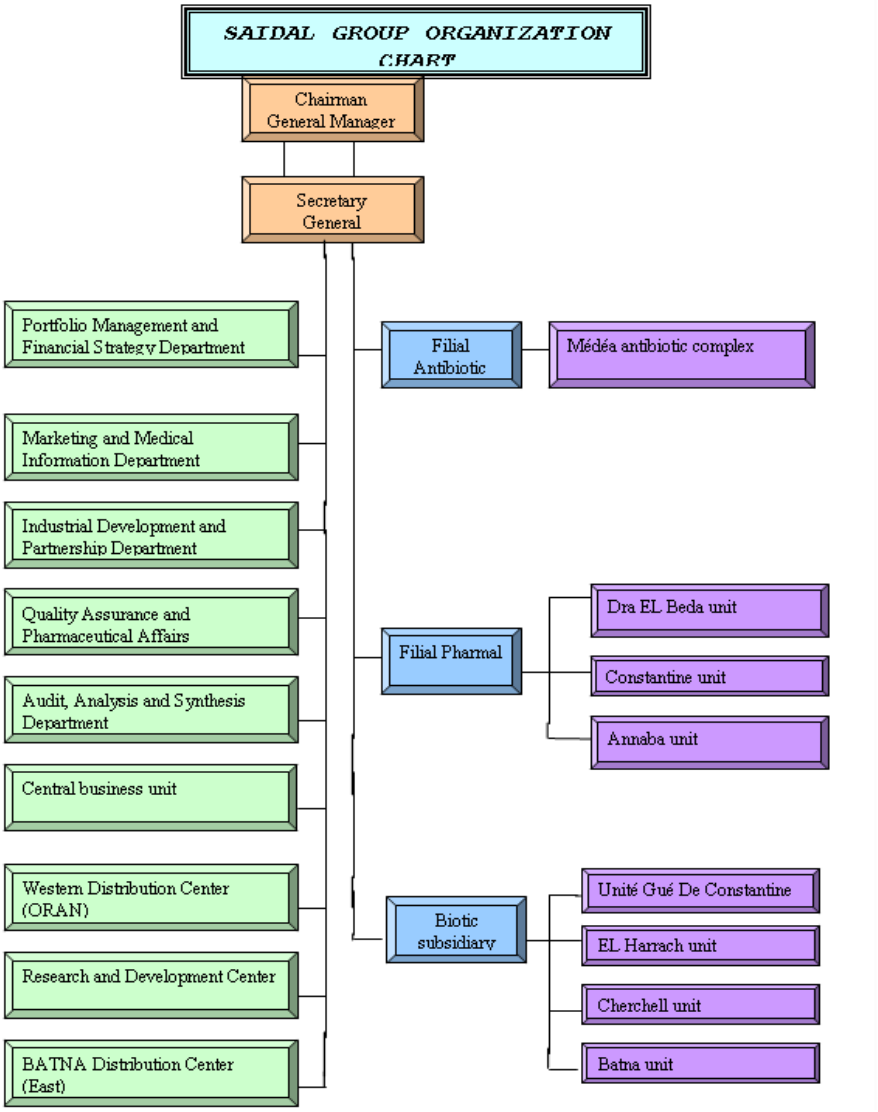
Appendices

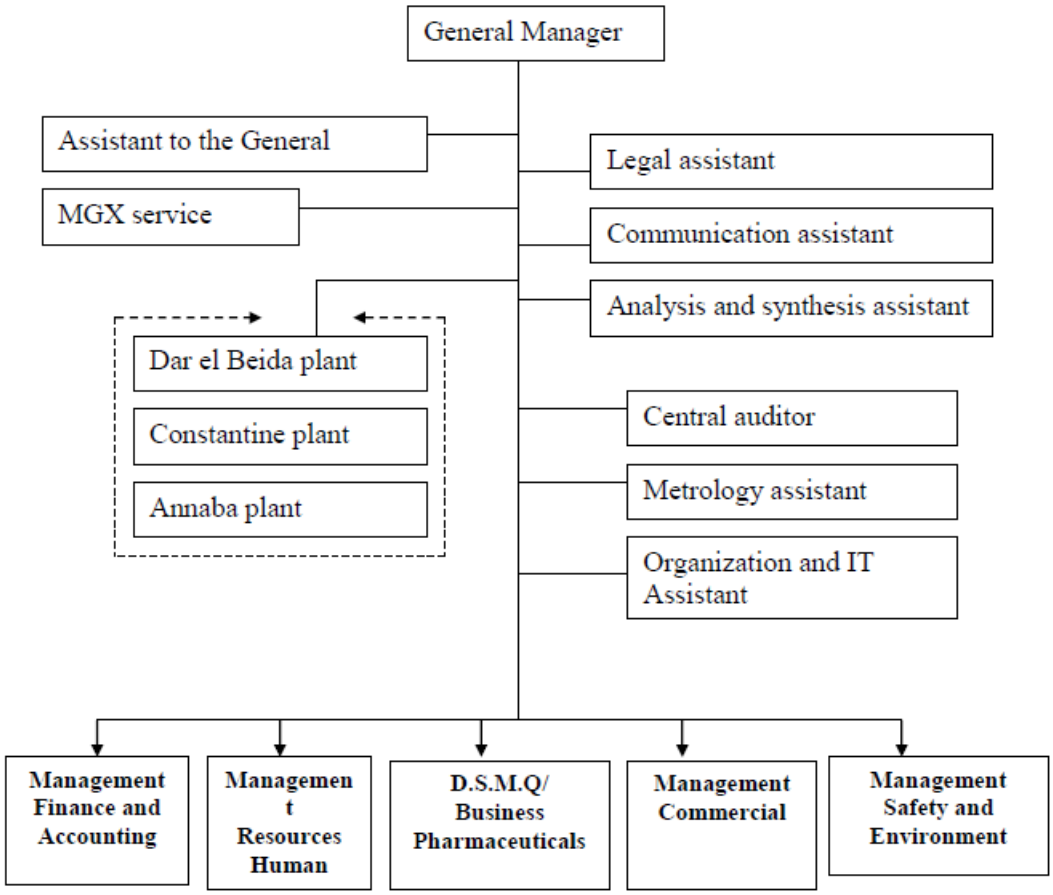
Appendix 01: SAIDAL GROUP ORGANIZATION CHART

Source : Administration internal document



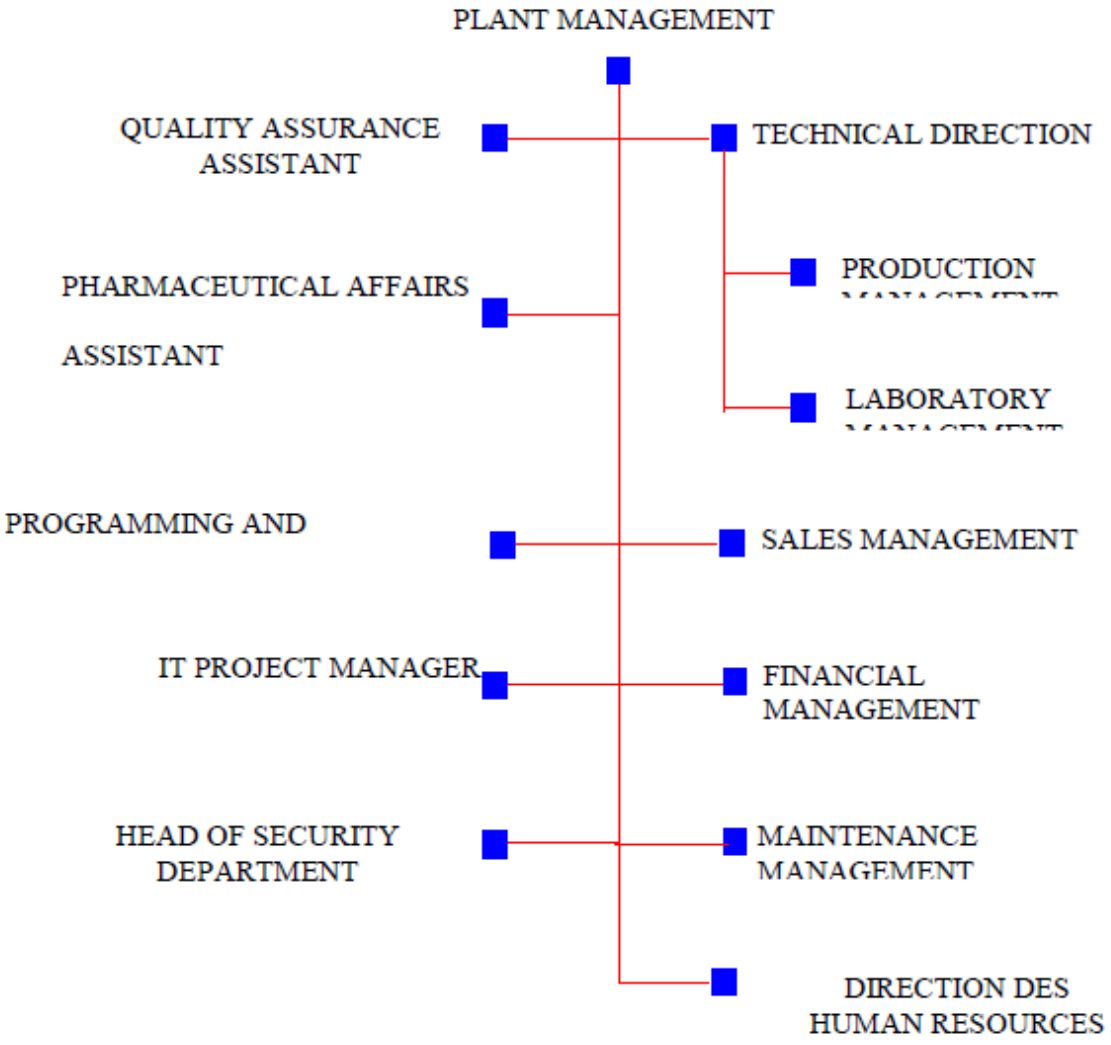
Appendix 02: Organization chart of Pharmal headquarter

Source: Administration internal document



Appendix 03: Organizational chart of SAIDAL Dar El Beida

Source : Administration internal document



Appendix 04: Different departements of the inventory management sub directorate.

Appendix 05: SAIDAL's documents references.

Source: SAIDAL's internal document.

Reference	Designation
IMP.01	Manufacturing orders
IMP.03	Weekly production schedule
IMP.04	Monthly production schedule
IMP.05	Packaging orders
LB/DSP/001/B	Production launch logbook

Appendix 06: The process of launching production.

Source: SAIDAL internal document

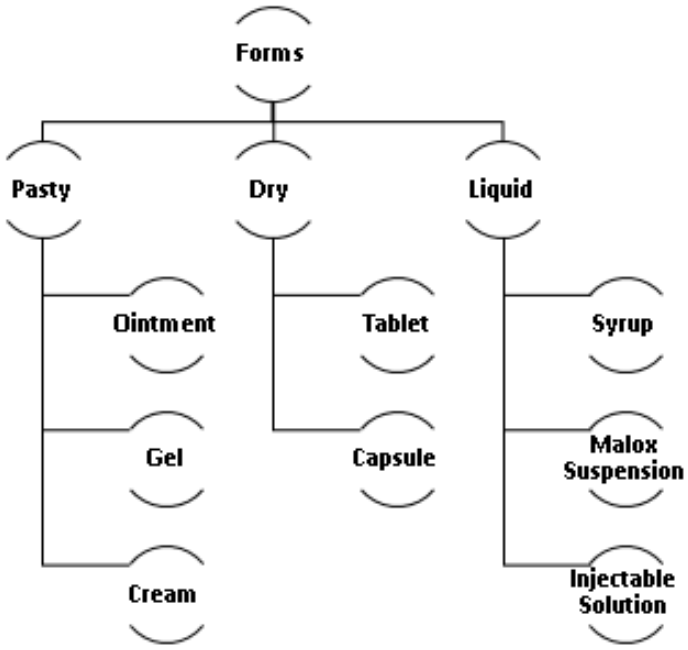
***Person in* charge**	**Task**
1. Scheduling assistant :	Receive the production and deglobalized sales forecast from the Assistant Site Manager in charge of analysis and synthesis. Draw up purchase requisitions for local purchases, taking into account raw material and packaging inventories, as well as purchase orders. Forward the requisition to the Purchasing and Supply Sub-Directorate
2. Scheduling assistant / scheduler :	Draw up the IMP.04 monthly production schedule in collaboration with the Production Site Manager, the Supply Assistant Manager, the Technical Manager, the Production Assistant Manager, the Laboratory Assistant Manager and the Maintenance Assistant Manager, depending on the availability of raw materials, the predisposition of existing stock equipment and sales forecasts. NB: The production schedule can be adjusted if necessary. Ensure the availability of raw materials and packaging items before each production launch by consulting the Raw Materials;Packaging Items inventory management software via the intranet from Inventory Management.
3. Scheduling Assistant / Scheduling Follow-up Assistant Production Manager :	Draw up the IMP.03 weekly production schedule in collaboration with the Production Assistant Manager and forward it to the Technical Manager, Production Assistant Manager, Quality Assurance Manager,

	Quality Control Laboratory Assistant Manager, Supply Assistant Manager and Maintenance Assistant Manager. NB: If the program is revised, update it (order number).
4. Scheduling assistant / scheduler :	Enter the date on the planning software and print the Manufacturing Order IMP.01 and Packing Order IMP.05 specific to the product to be manufactured in 3 copies (the original and the 2 counterfoils).
5. Scheduling assistant :	Sign the Manufacturing Orders IMP.01 copies (the original and the 2 counterfoils) and submit them to the Quality Assurance Secretary for stamping with the "quality assurance controlled copy" stamp >>.
6. Secretary - Quality assurance :	Check the printed Manufacturing Order IMP.01 and Packing Order IMP.05 against the reference Manufacturing Order IMP.01 and Packing Order IMP.05, previously validated by the Quality Assurance Manager and the Technical Director, and stamp them "< quality assurance controlled copy".
7. Scheduling assistant / scheduler :	Fill in the "< production start LB/DSP/01/B)" log book and send the IMP.01 production order and IMP.05 packaging order to the S/DP for approval.
8. Assistant Production Manager :	Receive the Production Order/IMP.01 and the oc IMP.05 from the scheduler and acknowledge receipt on the "Production start-up" log book LB/DSP/01/B Send IMP.01 production orders and IMP.05 packaging orders to the head of the production department.
Ordering raw materials	

5. *head of manufacturing department :*	Check the quantities of raw materials for the product to be manufactured on the IMP.01 Production Orders and sign them. Hand in IMP production orders. 01 to the Deputy Production Manager for signature. Forward to the head of the central weighing department the production file containing 3 copies of the IMP .01 production orders.
6. *Central Weighing Department Manager :*	Send IMP.01 production orders to the Raw Materials department manager for delivery of raw materials.
7. *Raw Materials Department Manager :*	Sign IMP.01 production orders and forward to S/D Stock Management for approval. Deliver raw materials in accordance with Manufacturing Order IMP.01, accompanied by the analysis bulletin.
8. *Central Weighing Department Manager :*	Weigh incoming raw materials and fill in: control numbers on analysis bulletins, batch numbers and weighed quantities of raw materials on Production Orders and sign them. Send one counterfoil of the Manufacturing Order to the Inventory Management Sub-Directorate and insert the original and the counterfoil in the batch file.
Ordering packaging items	
6. *Packaging Department Manager*	Check quantities of packaging items on IMP .05 packaging orders and sign jointly with production assistant manager.

	NB: delivery of items takes place after the product has been manufactured.
7. Head of Packaging/ Head of packaging Department:	Hand over the IMP 05 Packaging Orders in 03 copies (the original and the 2 counterfoils) to the Head of the Packaging Article Warehouse Department.
8. Warehouse Packaging Department Manager :	Fill in control numbers, batch numbers and quantities of packaging items on IMP.05s and sign. forward IMP .05 packing orders to S/D Stock Management for approval
9. Head of the Packaging Department :	Deliver packaging items in accordance with IMP.05 packaging order. Keep a counterfoil of the IMP.05 Packing Order and give the original and the counterfoil to the Head of the Packing Article Department.
10. S/D Stock Management :	Keep a counterfoil of the IMP.05 Packing Order and give the original and the counterfoil to the Head of the Packing Article Department.

Appendix 07: Diffrent forms that SAIDAL produces**.**



Appendix 08: SAIDAL's documents references.

Source: SAIDAL's internal document.

Reference	Designation
IMP001	Valued status of non-conforming products (Semi-finished product, Packaging item, Finished product, Raw material): A sheet which contains; the designation of the product, the quantity(KG) , the number of batch, the nature of product, date of peremption , value (DA) and the observation). This document is signed by the head of the stock management department and endorsed by the sales manager.
IMP002	State of non-conforming products (semi-processed product): a sheet containing the product designation, quantity, batch number, type of product and date of expiry, this sheet is signed by the production manager.
IMP003	Product sheet for reform: a complete document which follows the withdrawal of products from stock. It indicates the type of product (raw material, packaging item, laboratory supply) and its precise designation. The stock manager fills in the supplier details (name, invoice number, delivery date) and the quantity to be culled. Next, a section dedicated to

	quality control, filled in jointly by several managers, specifies the reason for the reform (defect, obsolescence, etc.), describes the anomalies and mentions the date of the control. Finally, the financial validation and approval of the reform is made by the visa of the finance director and the signature of the production site manager, including the validation date. A "Remarks" field allows you to add additional information. Once completed and signed, this form becomes an essential supporting document for rigorous inventory management and tracking of product reforms.

Appendix 09 : The process of non-compliant product reform.

Source: SAIDAL internal document.

Person in charge	Task
1- *Sales manager*	Draw up a monthly statement (IMP 001), duly stamped, of non-conforming products (raw materials, packaging items, finished products, semi-finished products, etc.) and/or products that have expired. notice: the Production Department must draw up and send to the Sales Department a statement of non-conforming products (semi-processed product) (IMP 002) together with the analysis reports. Fill in and sign the product sheet for culling (IMP 003) and send it to the technical manager, together with the analysis reports and the status of non-compliant products (Raw material, Packaging item, Finished product, Semi-finished product).
2- Technical manager	Put together a file for the reform of non-conforming products Convene the "commission de réforme des produits non conformes".

3- Reform commission	Hold a meeting to validate the culling of non-compliant products and draw up a culling report.
4- Laboratory Director/ Quality Management System Manager/ Technical Director	Complete and sign the parts of the product sheet intended for reforming.
5- Technical manager	- Forward the original reform file to the CFO. Notice: A copy of the reform file must be filed with the technical department.
6- Finance director	- Check the culling file for non-compliant products, fill in and sign the product sheet for culling. Forward the non-conforming product reform file to the Plant Manager for approval.

Appendix 11: The process of Biological waste management.

Source: SAIDAL internal document.

Person in charge	**Task**
1- Analyst	Decontaminate equipment used for handling micro-organisms by autoclaving at 121°C for 30 minutes. (flasks, test tubes, pipettes, petri dishes, etc.) Complete the decontamination management register, contamination management register and equipment registers. Collect decontamination waste in garbage can liners.
2- Quality Control Laboratory Manager	Draw up and sign a release form, and forward it to stock management.
3- Store section manager	Transporting decontamination waste for incineration Send a copy of the discharge with acknowledgement of receipt from the organization concerned to the quality control laboratory manager.

Appendix 12: Quantity of raw materials needed to produce a batch of NATRI toothpaste.

Source: Saidal intern document.

Raw material designation	Quantity (kg)
Sodium Fluoride	0.275
Sodium Benzoate	50
Sodium Monofluorophosphate	8.538
Sodium Carrageenate	13.750
Sodium Hexametaphosphate	2.5
Sodium Lauryl Sulfate Needle	25
Simple Nipagin	1.25
Titanium Dioxide	9.375
Sodium Saccharinate	0.5
Neubourg Silica	50
70% Non-Crystallizable Liquid Sorbitol	312.5
Anhydrous Disodium Hydrogen Phosphate	1.25
Colloidal Silica Hydrate (Tixosil 73)	135
Colloidal Silica Hydrate (Tixosil 43)	115
Mint Compound Essence	15.95
Purified Water	509.612
Total	1250

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