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GUIDANCE FOR IMPLEMENTATION OF STANDARD ISO 14001 IN A GALVANIC COMPANY

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Abstract

Nowadays, with the increase of pollution and the advance of climate change, Environmental Management Systems (EMS) are becoming more important and necessary to help companies and society to be less harmful to the environment. The present work focuses on the implementation of the standard ISO 14001:2015, a practical tool for organizations aiming to successfully manage their environmental responsibilities. The implementation is done by following the standard specifications listed at European Community regulation 1221/2009 EMAS III, with the objective to comply with all the certification requirements of ISO 14001:2015. Furthermore, the implementation phases explained during this project can be considered as a guideline of how the standard can be implemented.

Specifically, the rule is implemented at *GALVANIX*, a fictitious galvanic corporation created and described using data from Environmental Authorisations of companies of the same type, in this case galvanic sector. Located at Barcelona, Spain, *GALVANIX* main activity is to produce profiles and sheets of aluminium highly resistant. Furthermore, in addition of the EMS, an Initial Environmental Review is carried out with the objective to know better the starting point of the company, facilitating the progression and implementation over time of the EMS.

During the description of the fictitious company, is noticed a lack of organization and efficient practices related on environmental aspects such as atmospheric emissions or waste management, as well as the suboptimal usage of resources like water, energy or raw materials. Thanks to the EMS, is believed these main problems are going to be solved while improving overall environmental performance.

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1. Introduction

The damage to the environment has been increased during the last three centuries, especially since the last quarter of the 20th century. Human activities are constantly exerting pressure on planet Earth through practises such as fossil fuels burning, deforestation, aggressive agriculture, and industrial processes, among others. All these facts have been highlighted the need of increasing efforts to protect the environment.

1.1 Evolution of environmental concern and the role of Environmental Management Systems

Humanity's Ecological Footprint (an indicator that measures the ecological assets that humanity requires to produce the natural resources it consumes and to absorb its waste) first exceeded global biocapacity (which is the ability of an ecosystem to produce useful biological materials and to absorb carbon dioxide emissions) in the early 1970s, and has done so every year since (Global Footprint Network 2019). This fact can be observed in figure 1, where is shown the difference between ecological footprint and earth biocapacity from 1961 until 2016.

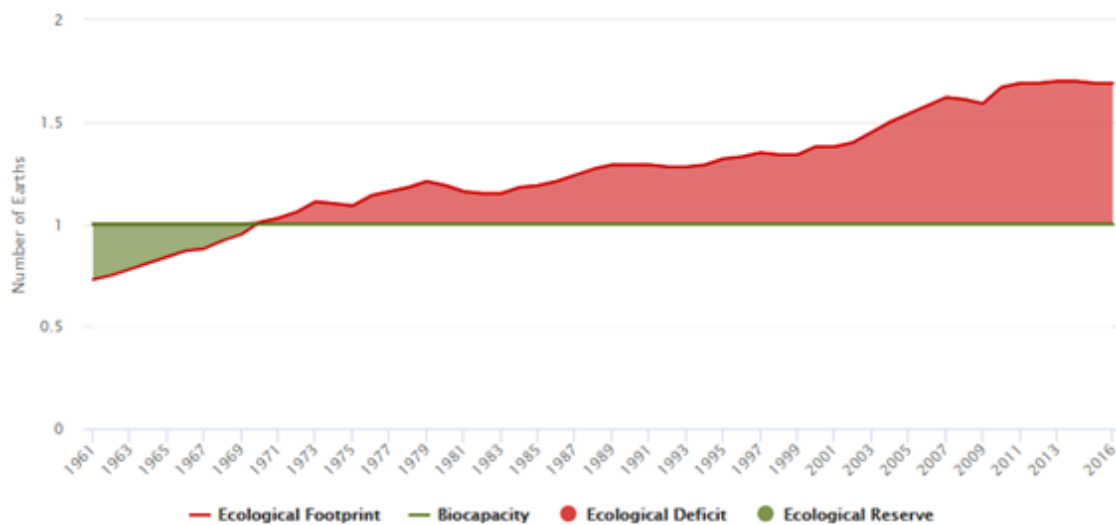


Figure 1: World ecological footprint related to number of earths. Source: Global Footprint Network.

This resulted in an ecological deficit where the growth of the world population and the development of new technologies cause a massive exploitation of resources. In other words, economic growth was at the expenses of environment. From that moment, and after the industrial revolution, the severity of the environmental problems became real.

Awareness and concern for the environment have been growing since the last quarter of the 20th century. For example, in the 1970s the Environmental Protection Agency (EPA) was created and the first Earth Summit was held in Stockholm, Sweden. It was the first major conference of the United Nations (UN) on environmental issues and marked a breakthrough for the development of international environmental policies. Later, new projects emerged such as the Brundtland Report

on Sustainable Development in 1987, the Montreal Protocol in 1989, which highlighted the importance of protecting the ozone layer, or the Rio de Janeiro summit in 1992, where it was established principles like ‘polluter pays’. It was in that same year that the first standard on Environmental Management Systems was created, the BS 7750.

Global warming is probably the greatest challenge humanity faces nowadays. The major greenhouse gas present in our atmosphere is CO₂, with a concentration of 441 parts per million (Figure 2). This value has not been exceeded during the past 420,000 years, and likely not during the past 20 million years. (IPCC 2001).

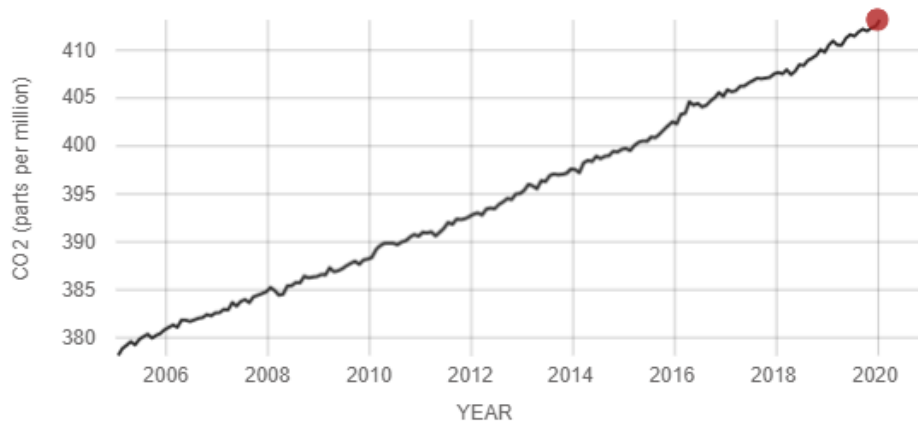


Figure 2. Concentration of CO₂ in parts per million (ppm) through time. Source: Monthly measurements from NASA Risks related to climate change are increasing and already affecting population health. Data was used to estimate that nearly 800.000 people die prematurely each year, only in Europe, because of dirty air and pollution (Lelieveld et al. 2019). In addition to that, each life is cut short by an average of more than two years (Lelieveld et al. 2019). Furthermore, exposing vulnerable population to extreme weather can compromise and violate human rights of future people, such as food security, safe drinking water and clean air (Nick Watts et al. 2018).

Aside from global warming and climate change, it is important to note there are other important environmental problems, such as the destruction of the ozone layer, loss of biodiversity and ecosystems, sea level rise, increased waste generation, deforestation and even illegal trafficking of species of animals. Therefore, there are many other environmental problems to mitigate and try to prevent from occurring.

However, efforts are being made by society. For example, politicians are increasingly recognizing environmental problems as one of which poses major risks to human health and wellbeing (Haines and Ebi 2019). Furthermore, its demonstrated by empirical analysis that environmental policies are increasing through time in democratic countries (Facchini et al. 2017). Moreover, society mindset is changing and evolving, thanks to concepts like circular economy or the increased use of renewable energy sources, for example.

Accordingly, systems to manage and lower the impacts we are causing to our environment are becoming extremely necessary. That's the main reason why Environmental Management Systems (EMS) were created, to help society and corporations to be less impactful to the environment.

1.2 Definition and types of EMS: which one is more suitable for a company?

EMS can be defined as a set of processes and practices that enables an organization to reduce its environmental impacts and increase its operating efficiency (EPA 2018). The key thing to understand is that firms adopt it voluntarily with the objective to provide continual improvement to the environmental performance, beyond what is required by law.

To successfully implement an EMS in a company, it is necessary to comply with the requirements of the standard, which are listed as a continuous cycle of improvement, review and evaluation:

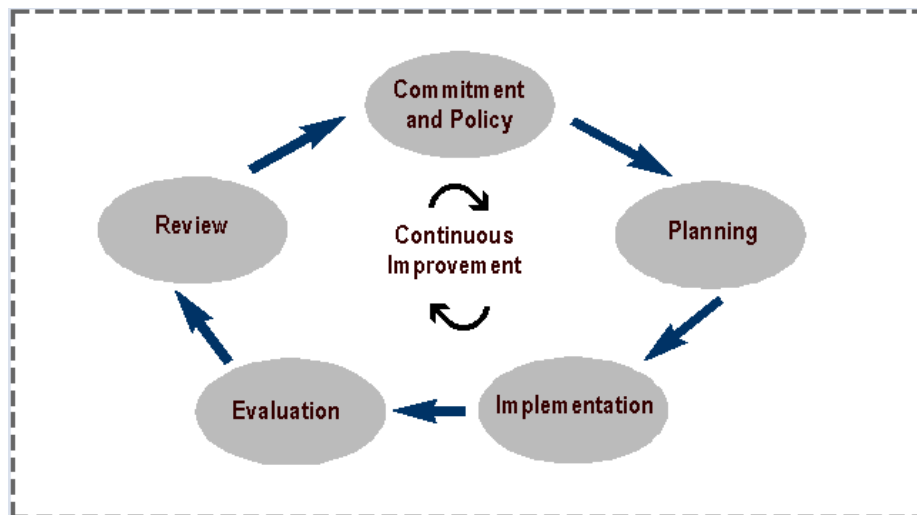


Figure 3: The continuous improvement cycle. Source: EPA

The cycle observed in figure 3 is required by 5 steps (EPA 2017):

- 1- Commitment and Policy: Top management commitment is a key part, as they should make available the necessary resources to establish the environmental policy of the firm.
- 2- Planning: Study your company in order to identify environmental aspects¹ of its operations, such as water pollutants or waste generation. Knowing your business facilitates defining targets and objectives. Finally, the planning stage ends with the creation of an action plan for meeting the targets established.
- 3- Implementation: Action plan is implemented. This needs employee training and awareness for all workers because new things are going to be done in the company. Employees need to know everything new, new things should be taught in order to work all together in the same direction and be more efficient.

¹ Environmental aspect means an element of an organisation's activities, products or services that has or can have an impact on the environment.

- 4- Evaluation: The company monitors every operation to evaluate if the objectives are being met.
- 5- Review: This last step requires top management cooperation, as they review the results of the evaluation to see if the EMS is working. This part is key to acquire continuous improvement for the company because the plan is revised to optimize the effectiveness of the EMS.

After these five steps (and in accordance with the EMS standard adopted), the company should choose a certification body that will ultimately audit the EMS implementation with the objective to analyse the compliance with the standard adopted, as well as check whether the system is effective and continuously improved.

Before doing the certification audit, the company should perform internal audits as well as a review by the management (which correspond to the aforementioned steps 4 and 5). This will give a chance to make sure the processes are developed according to planification and the resources are effectively used. Finally, if non-conformances are detected, corrective actions should be performed.

Finally, the certification body will review the EMS's documentation (primarily written procedures and records) to verify the company has addressed all necessary requirements of the standard adopted. During this main certification audit, the external auditor will perform an on-site audit where they will review the records accumulated of the process, including the internal audits, management review and corrective actions. After that, the auditor will issue a report detailing their findings and, if the company does not have any major non-conformances with the requirements, it will be certified for three years. After that, the company must carry out the renewal of their certificate, making sure the maintenance and continuous improvement is applied to the EMS

It is true that the implementation of an EMS can be considered as an investment of resources and time for the company. It can be hard and expensive at first. However, it brings several benefits in a long term.

First of all, business can save up economical costs by optimizing the use of raw materials, energy, and can help with the management of waste generation and atmospheric emissions. Furthermore, an EMS can improve the imagen al clients, shareholders, press and public in general. Not only that, it can increase the employee motivation and implication in the company, as they feel more satisfied with its work. In conclusion, is really probable a company that implements a EMS, in a long run, can increase its capital, production and popularity among its clients (Nick Watts et al. 2018).

There are two types of EMS: ISO 14001 and Eco-Management and Audit Scheme (EMAS III). Both provide guidance and direction on how an organization should manage and mitigate its impact on the environment. However, they have specific characteristics that cause the differences between each other. In table 1 is shown the main differences between these two systems.

Table 1. Main differences between ISO 14001 and EMAS. Source: Own elaboration

Aspect	ISO 14001:2015	EMAS
Standard type	Elaborated by a private organization (International Organization for Standardization)	Regulation from European Union
Geographical scope	International	Currently international, but initially at European level
Initial Environmental Review	No obligatory but recommended	Obligatory and need to be certified by an external agent.
Employee commitment	Less commitment	More commitment
Certification	National accreditation bodies	Environmental verifiers licensed by governmental bodies

The biggest difference when comparing the requirements is that EMAS has stricter interpretation of how environmental processes have to be planned and managed. For example, ISO 14001:2015 recommends the company to identify the environmental aspects and impacts, while EMAS requires to perform a more comprehensive environmental review of your processes. In addition, EMAS requires more commitment from employees than ISO. This is an important part because an EMS implies changes in the corporation that the workers have to learn and assimilate. To sum up, EMAS usually has additional requirements with regard ISO 14001. Because this reason, is usually recommended corporations that doesn't have any EMS implemented, they should begin with ISO 14001:2015. After implementing this standard, getting used to its complexities and requirements, the company can jump to the EMAS. However, implementing directly the standard EMAS can be hard and discouraging.

2. Justification and objectives

EMS are becoming more necessary to business each day. First, as stated before, environmental risks and issues are raising really fast. EMS are an instrument that can help to decrease impacts to our environment by improving environmental performance of companies.

Moreover, social pressure is increasing. Nowadays, more people are taking into account the environmental behaviour of certain companies to decide what they want to consume. Apart from

that, economic competitiveness is also increasing. Business have to be more efficient to maintain the clients, having a competitive price in the market.

On top of that, legislation is slowly becoming stricter. This is reasonably because communication and technology is providing greater interaction between citizens of different countries. This fact has led to the diffusion of common norms that are becoming translated into new and severe laws (Hillary 2004).

The objective of the present work is to provide a guideline to implement ISO 14001 on a fictitious galvanic corporation located in Spain, which its industrial activity is surface coating and treatment aluminium metals through anodizing processes. Specifically, the project aims to:

- Define and create a credible fictitious galvanic company.
- Provide a guideline to perform an Initial Environmental Review to the company.
- Provide a guideline to implement the standard ISO 14001 in the company.

3. Methodology

As explained before, this project will simulate the implementation of an ISO 14001:2015 in a fictitious company created during this study. This is because there aren't enough resources and availability to implement it in a real one.

The fictitious company is created and described using data from different companies of the same type, in this case galvanic corporations. Data resources are from Environmental Authorisations from the department of Sustainability of Catalonia's Government (Gencat, n.d.). In those documents, are described most of the information necessary to describe a viable and in real scale corporation.

In addition, an Initial Environmental Review (IER) will be done. Data will be examined with the objective to identify what the company needs to do in order to increase environmental performance.

On the other hand, requirements for the ISO 14001:2015 will be taken from EMAS III European Community Regulation 1221/2009, related to the voluntary participation of corporations to a community system of management and environmental auditory. Specifically, ISO requirements are listed in section A of the Annex II of the standard. The objective of following those indications is to comply with the certifications requirements and successfully implement ISO 14001:2015.

4. Description and organization of the company

In this chapter, the fictitious company GALVANIX will be described with its location, organization and production process.

4.1 GALVANIX: general information

GALVANIX is dedicated to surface coating and treatment aluminium metals through anodizing processes. Is located next to an industrial area at Mollet del Vallés, Barcelona, Spain. The exact location can be observed in figure 4.



Figure 4: Location of GALVANIX, at Mollet del Vallés.
Source: Adapted from Google maps

Taking into consideration the daily activities and the production process, the EMS will concern all departments and processes of the plant, such as Research & Development, Commercial and Plant Operations. However, as the production process has the most environmental potential, the EMS will be more focused on this part.

It has been established that the company was created in 2002. Located in an industrial area next to a residential area, it has two main warehouses: one with the anodises section and the other is used as storage. The steps made during the production process, in its different aluminium baths, are degreasing, water wash and stirring, pickling, neutralized, anodized electrolytic bath, colouring and sealing. Thanks to 15 employees working on the production process, they generate up to 1.500.000 m²/year of profiles and sheets of aluminium highly resistant that they distribute and sell to many different construction and manufacturing companies.

4.2 Production process: Electrolytic Anodizing

The process consists of a series of consecutive baths in different vats to obtain the material with a layer of aluminium oxide. In this way, aluminium material is obtained with great protection against corrosion and high resistance to abrasion.

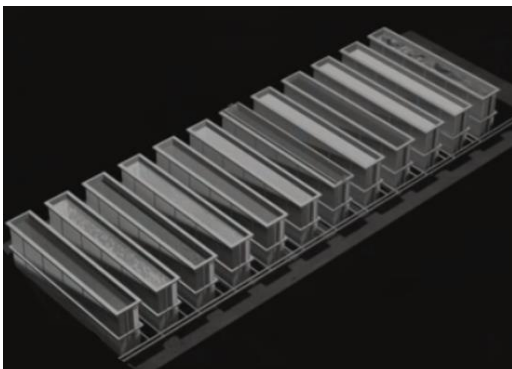


Figure 5. Consecutive vats where all the baths are done during the whole process. Source: AEA

Aluminium has properties highly appreciated in the industrial world. Its low specific weight, its good mechanical qualities and its decorative appearance have allowed it to occupy a privileged place in the most diverse applications for industrial business. From producing materials of daily use such as pans, water bottles or screws to industrial uses such as architecture. By electrolytic anodizing with sulfuric acid, the desired material is obtained. The process is defined below and outlined in Figure 6.

First, the aluminium surface to be anodized is chemically prepared. To do it, aluminium metal material is subjected to a degreasing bath to obtain a clean surface. Subsequently, a wash with water and agitation is carried out, followed by a pickling bath to remove the natural oxide of the material and leave it with a satin appearance. Caustic soda in 5% is used in this process.

Afterwards, a wash and neutralized with nitric acid is carried out to remove the remains of the previous stripping and to have a clean and neutral surface. After these processes the material prepared to form anodic oxidation on aluminium is already available.

Aluminium charge is introduced in an electrolytic bath with sulfuric acid. The pieces to be treated act anodically, since the process consists of forming a layer of oxide at the expense of the material itself, without providing other materials. An alumina film with small pores is formed. These pores increase the electrolytic flow and, therefore, an aluminium oxide layer is formed by chemical bonding forces, called an anode layer.

Then the coloration is carried out, where metal salts are deposited in the pores of the anodic layer to obtain different ranges of colours.

To finish the process, pores have to be seal. The sealing process is the most important treatment, since it determines the resistance of the anodic layer. For this process, the material must first be thoroughly washed to leave the pores without acids. At a later stage, a steam bath is performed to hydrate the alumina, increasing its volume and closing hermetically the pores. Now the material is ready for its distribution. The whole process is shown in Figure 6.

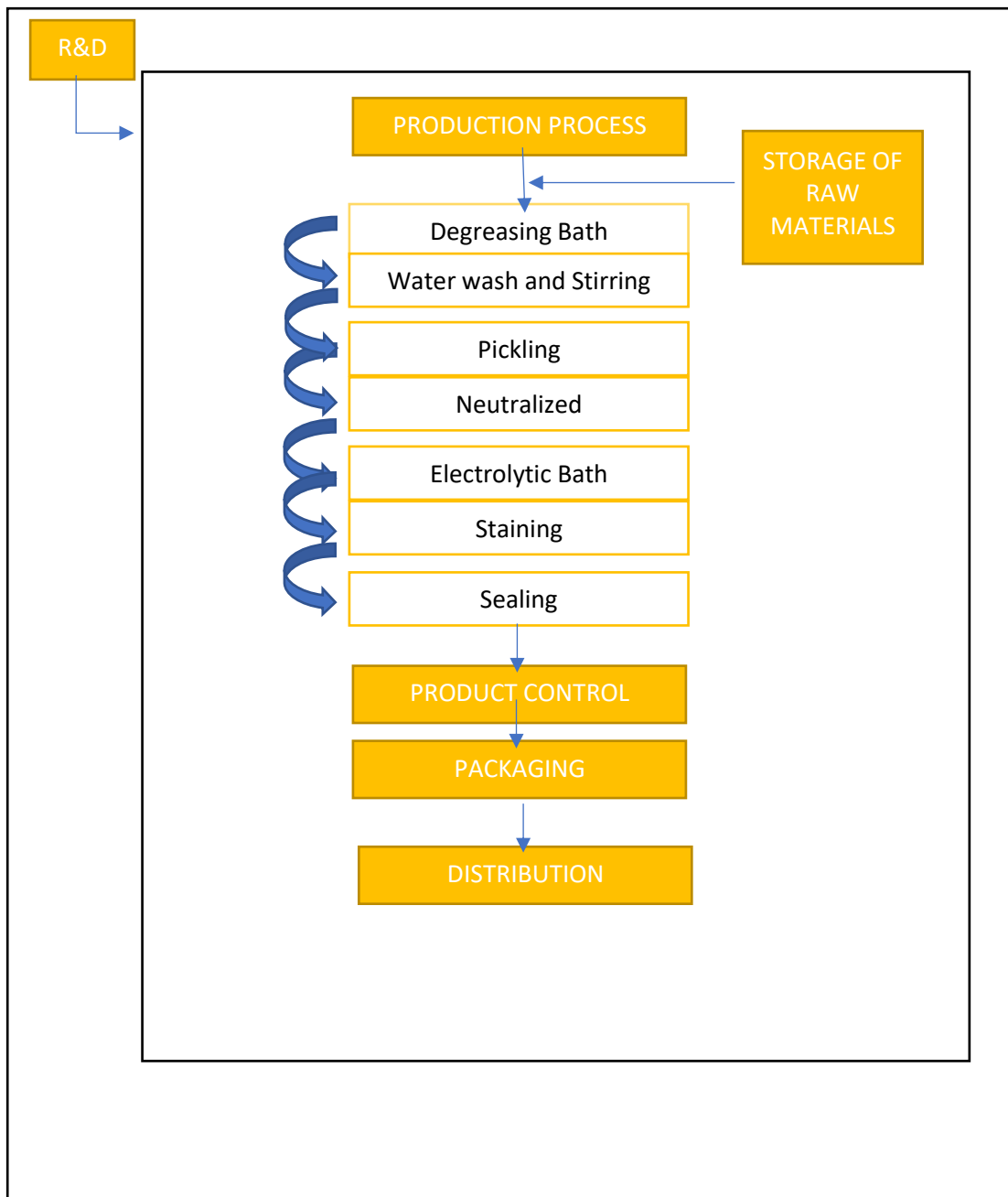


Figure 6. Production process diagram. Source: Own elaboration

During this process, there are quite a few pollutants and emissions to the environment that require a control. First of all, from pickling, electrolytic bath and principally the use of natural gas, fumes containing hydrochloric and sulfuric acid, nitrogen oxides, carbon dioxide and particulate matter, are emitted. In addition to that, plenty of wastewater containing chemicals such as nitrogen, phosphor or chrome, are discharged to municipal sewage system. On top of that, there is a lot of waste produced during the whole process, for example used solvents and acids, or plastic and paperboard from packaging. Other types of environmental issues such as light and noise pollution, have to be also considered.

To sum up, the production process is highly patterned and regulated, with a clear and fixed methodology. However, on the other hand, being a hot process that requires the use of fuel, machinery, and large amount of chemicals, it can be complex to handle. Pollutants and emissions associated with the activity are regulated and controlled by public administration, apart from the necessity of controlling the whole process, so the environment is not severely damaged.

4.3 Plant distribution

References consulted to acquire a global understanding of the galvanic sector (the aforementioned Environmental Authorisations) were very useful to develop a layout of the distribution of the plant. Accordingly, the distribution of the plant is showed in Figure 7.

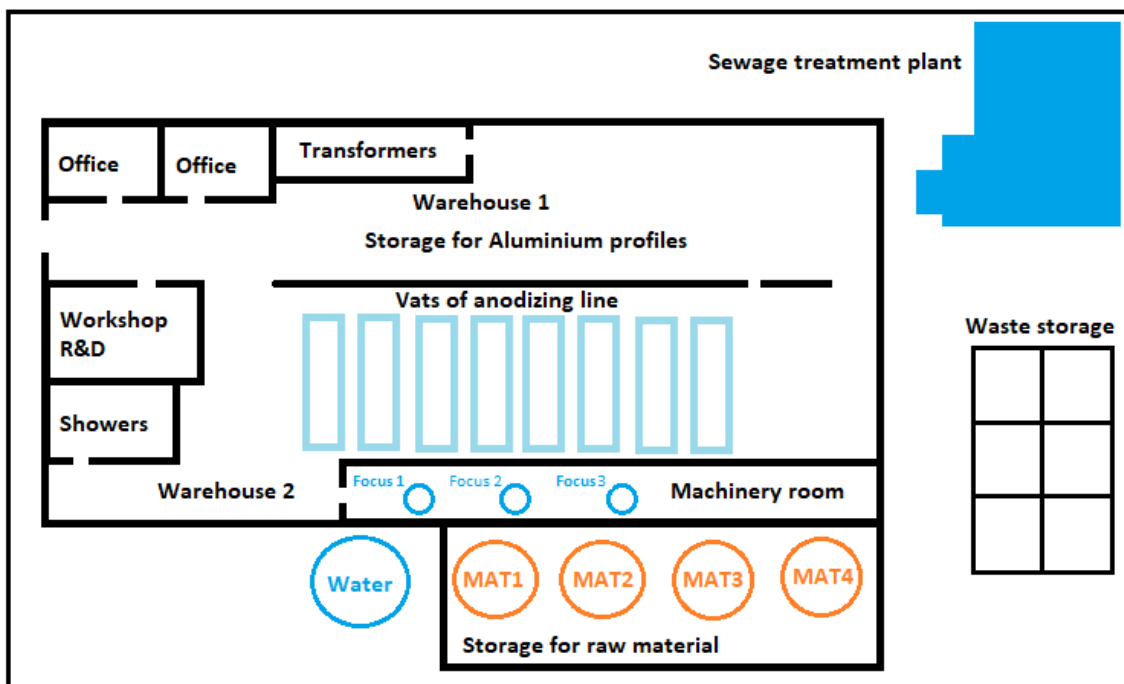


Figure 7. Galvanix plant. Source: Own elaboration

The plant is divided in two main warehouses. The first one, is mainly used as a storage for the aluminium profiles produced. As we can see, is located next to the entrance, so the product can be easily taken out of the industry. Also, we can find offices where administrative tasks are developed, such as logistics or talking with the clients. In the workshop, is where R&D projects are conducted in order to optimise the use of raw materials. Furthermore, research projects are done to optimise production process or try to find and keep up with the market evolution.

In the second warehouse is where production process occurs, in the vats and machinery room. Moreover, is important to point out that the company has three focus, where greenhouse gases, such as CO₂, CH₄ or N₂O, or pollutants such as SO₂ and PM₁₀, are emitted to the atmosphere. Next to the machinery room, raw materials are stored. Finally, outside the plant we find the sewage treatment, where wastewater from the plant is treated to comply with legislation and the storage of waste that comes from the production process, sewage and workshop.

4.4 Assumptions that have been considered

In this section it has been detailed the specific assumptions that has been considered to develop the assessment:

1. The company has specific deficiencies related to environmental aspects of its activity. Firstly, due to the fact the factory facilities are old (it has been assumed that the factory was built in 2002), there is excessive consumption of energy, water, and raw materials. In contrast, employees are experienced in the production process thanks to the years of dedication in this kind of sector.
2. The factory generates wastewater discharges into the municipal sewer system of Barcelona, which, in some water analytics, it exceeds the values allowed by legislation.
3. Regarding atmospheric emissions, the company has 3 focus of emissions which are out of maintenance and not well revised. There is a high risk of non-compliance with the legislation. In addition to this, noise pollution is noticeable for the few neighbours in the nearby of the industry. Machines are not well anchored and there are not measures to prevent noise transmission either. On top of that, light pollution is also an issue for some neighbours. Complaints from neighbours and environmental associations in the area have arrived at the company, putting the commercial activity at risk. This caused the regional administration to have more attention to *GALVANIX*.
4. Regarding waste material, is believed it can be improved as plenty of solvents and acids already used are thrown away, apart from the use of too much plastic and paper during packaging process. Furthermore, they can be better organised by improving conditions they are stored.

5. Implementation of ISO 14001:2015

As said in the Methodology section, requirements for the ISO 14001:2015 will be taken from EMAS III European Community Regulation 1221/2009. In order to implement successfully the standard, is mandatory to comply all the requirements listed at the document: organisation context, scope, leadership, environmental policy, responsibilities and authorities, planning of the EMS, environmental aspects, environmental legal requirements, environmental objectives and actions, resources and communication, performance evaluation, internal, external and registration audit.

Before starting with the list of requirements, in this project it has been considered pertinent to carry out an Initial Environmental Review (IER). This step, as can be seen in table 1, is not mandatory for the ISO standard. However, it is considered a useful step for the identification of environmental aspects, their impacts and significant evaluation. Through an IER, it is easier to identify the starting point of the company. This process will facilitate to know the progression

over time of the EMS and save future work during the implementation of the standard. For the redaction of the IER, steps established at Annex I from EMAS III European Community Regulation 1221/2009 will be followed.

5.1 Initial Environmental Review

To carry out a correct Initial Environmental Review, six essential elements are required: determination of organisational context, identification of interested parties and its needs, identification of the applicable legal requirements relating to the environment, identification of direct and indirect environmental aspects, evaluation of feedback from the investigation of previous incidents, determination and documentation of risk and opportunities.

It will be assumed the company *GALVANIX* has not had any previous incident, so this section will not be evaluated.

5.1.1 Organisation context

To begin with the IER, external and internal issues shall be determined. Taking into consideration the characteristics of the company explained in chapter '4. *Description and organisation of the company*', in table 2 are described the main weaknesses and strengths of the company.

Table 2. Description of weaknesses and strengths of GALVANIX. Own elaboration

Weaknesses	Strengths
Factory facilities are old	Experienced employees
Excessive consumption of energy, water and raw materials	Business economic profitable
Excessive noise pollution	Product quality
Excessive light pollution	Communication and confidence with clients
Eventually, there is no compliance related to the wastewater discharges into municipal sewage system	No historic confrontations or fines with the public administration
Emissions focus are out of maintenance	Good relationship with the public, well known-company
Waste materials are not well organised	Own sewage treatment plant available

Apart from the internal conditions of the company, it is also necessary to consider the external conditions. The company is located on an industrial area. However, it is relatively close to a residential area and, accordingly, some residents have complained of noise and light disturbances. Another important factor is that the wastewater produced in the company goes to an urban wastewater treatment plant, so the levels of contamination of water discharges should comply with legal requirements. In addition, the company must control its atmospheric emissions to comply with the requirements of its Environmental Authorisation.

5.1.2 Identification of interested parties and its needs

Interested parties include both people and organisations affected, or possibly affected, because of the activity of the company. Therefore, it is essential to comprehend the needs and expectations of the interested parties. Furthermore, the company must decide which needs are included inside the EMS.

In Table 3 are listed all the interested parties, its needs and expectations and the requirements for the EMS and included in the standard.

Table 3. Identification of Interested Parties. Source: Own elaboration.

Interested Party	Needs and expectation	Requirements for the EMS
<i>Mollet del Vallés</i> Townhall	Compliance with environmental legislation. Municipal taxes. Municipal agreements. Information request	Strict compliance with environmental legislation. Payment of all required taxes. Compliance with municipal agreements. Sending requested information.
Public Administration from Catalonia Government and Ministry of Environment of Spain	Compliance with environmental legislation. Regional taxes. Regional agreements by the institution. Information request. Granting of possible financial aids.	Strict compliance with environmental legislation. Payment of all required taxes. Compliance with municipal agreements. Sending requested information. Obtaining financial aid to improve environmental performance.
Investors	Obtain economic benefit. Guarantee stability. Improve the corporate social image. Improve environmental training and working conditions	Strict compliance with environmental legislation. Specific training for workers about workplace and safety rules.
Employees	Environment training at workspace. Occupational Health & Safety.	Specific training for workers about workplace and safety rules. Do not use high dangerous substances.
Workers Union	Security and health at workplace. Training in the workplace. Attention to complaints and suggestions from workers.	Specific training for workers about workplace and safety rules. Do not use high dangerous substances.
Client	Products with less environmental impact. Customer Service.	Pollution prevention. Environmentally sustainable product.

Interested Party	Needs and expectation	Requirements for the EMS
Suppliers	Obtain economic benefit. Fair competition	Provide environmentally sustainable products
Haulier	Obtain economic benefit. Fair competition	Efficient driving techniques.
Neighbours	Good environmental and social behaviour from the organization. Transparency. Pollution control. Attention to complaints.	Public information about environmental behaviour of the organization.
Environmentalist groups	Good environmental and social behaviour from the organization. Pollution control. Attention to complaints.	Public information about environmental behaviour of the organization.

5.1.3 Identification of the applicable environmental legal requirements

The environmental legal requirements are divided in five categories, as observed in table 4. Each category has its own Autonomic (Catalonia), State (Spanish) and European legislation. In addition, all categories have listed a summary of the most important requirements that have to be done by the company in order to keep with its activity.

On the other hand, the activity of *GALVANIX* is subjected to Environmental Authorisation in compliance with Law 20/2009, of February 27, related to the protection of the environment. Accordingly, *GALVANIX* obtained a favourable resolution of its Environmental Authorisation on 2002 and since then must comply with the controls detailed on it as a requirement to continue developing its activity.

Table 4. Environmental legal requirements for GALVANIX. Source: Own elaboration

Environmental Category	Autonomic laws Catalonia	State laws Spain	European Union	Legal requirements to comply
Atmospheric pollutants emissions	Law 20/2009	R.D. 773/2017 R.D.L. 1/2016 Law 5/2013 R.D. 815/2013	Directive 2010/75/UE	Legal limits of pollutants emissions. Pollutant release and transfer register (PRTR). Environmental inspections from Public Administration.
Water	D.L. 3/2008 D. 130/2003	R.D.L 1/2001	-	Canon for discharge authorization. Legal limits of pollutants in sanitary water discharge and from production process. Pollutant release and transfer register (PRTR). Environmental inspections from Public Administration.
Waste material	PRECAT20	R.D 210/2018 Law 22/2011	-	Register of Industrial Waste Producers. Annual declaration of industrial waste. Annual declaration of industrial plastic waste. Legal compliance of waste conditions and organisation. Environmental inspections from Public Administration.
Acoustic Pollution	D. 176/2009 Law 16/2002	Law 37/2003	Directive 2002/49/CE	Legal limits of acoustic levels. Environmental inspections from Public Administration.
Light Pollution	D. 190/2015 Law 6/2001	R.D. 1890/2008	-	Legal limits of lighting. Environmental inspections from Public Administration.

5.1.4 Identification and evaluation of environmental aspects

For the identification of environmental aspects, it is recommendable to review all the activities carried out by the company, such as the production and management processes, auxiliary services or transport operations. Once identified, it is necessary to provide each aspect with an indicator and a performance evaluation system, through which its behaviour can be measured, evaluated and controlled. Furthermore, the information provided by the indicator should be comparable through time. This allows the identification of favourable environmental trends, such as, for example, the reduction of tons of waste generated per ton of production. On the other hand, corrective actions can be made if unfavourable trend is detected, avoiding the increase of this tendency. To sum up, the indicators are a quantifiable metric that reflects the performance of the company to achieve its environmental objectives.

In Table 5 are identified all the environmental aspects, both direct and indirect, together with the performance evaluation criteria: “ K_i ” stands for indicator value and “ K_r ” for reference value (during the performance and monitoring part of the project the indicators will be more detailed).

The environmental aspects have been divided in 6 categories: wastewater (WW), atmospheric pollution (ATM), waste generation (WG), natural resources (NR), soil (SO) and emergencies (EME).

Table 5. Environmental aspects of GALVANIX corporation. Source: Own elaboration

Aspect's Class	Aspect	Indicator Value (K _i)	Reference Value (K _r)	Acceptable Performance Evaluation Criteria for EMS
Direct Environmental Aspects				
WW	Discharge of process waters	Annual average	Canon for discharge authorization, based on legal limit (D. 130/2003)	$K_1 \ll K_r$
	Sanitary waters discharges	Annual average	DUCA parameters based on legal limits (D. 130/2003)	$K_1 \ll K_r$
ATM	Combustion gases (NO _x)	Measurement	Legal Limit (R.D. 773/2017)	$K_1 \ll K_r$
	NMVOCs emissions	Measurement	Legal Limit (R.D. 815/2013)	$K_1 \ll K_r$
	Methane	Measurement	Legal Limit (R.D. 815/2013)	$K_1 \ll K_r$
	Carbon dioxide	Measurement	Legal Limit (R.D. 815/2013)	$K_1 \ll K_r$
	Particles emissions (PM10)	Measurement	Legal Limit (R.D. 773/2017)	$K_1 \ll K_r$
	Noise pollution	Measurement	Legal Limit (D. 176/2009)	$K_1 \ll K_r$
	Light pollution	Number of light equipment that meet legal requirements	Number of light equipment in the company	$K_1 = K_r$
WG	Hazardous waste	Waste's annual quantity generation / annual production	Average value of the ratio for the last 4 years	$K_1 > K_r$
	Non-Hazardous waste	Waste's annual quantity generation / annual production	Average value of the ratio for the last 2 years	$K_1 > K_r$
SO	Soil and groundwater	Measurement	Legal control	$K_1 < K_r$
NR	Natural gas consumption	Quantity consumed / annual production	Average value of the ratio for the last 4 years	$K_1 \leq K_r$
	Water consumption			
	Electricity consumption			
	Diesel consumption			
	Packaging material (plastic and paper)	Quantity used	Average value of the last 4 years	$K_1 \leq K_r$

Table 5. Environmental aspects of GALVANIX corporation. Source: Own elaboration

Aspect's Class	Aspect	Indicator Value (K _i)	Reference Value (K _r)	Acceptable Performance Evaluation Criteria for EMS
EME	Emergency cases	Number of Emergency cases	Number of Emergency cases	K _i = K _r
Indirect Environmental Aspects				
ATM	Environmental behaviour of material suppliers	Environmental Aspect controlled by the material suppliers	Sustainable environmental behaviour	K _i = K _r
	Energy efficiency in the distribution process	Environmental Aspect controlled by the transporter	Sustainable environmental behaviour	K _i = K _r
NR	Environmental behaviour of natural resources suppliers	Environmental Aspect controlled by natural resources suppliers	Sustainable environmental behaviour	K _i = K _r

5.1.5 Risks and opportunities determination: SWOT analysis

A SWOT analysis stands for Strengths, Weaknesses, Opportunities and Threats. It assesses these four aspects of the business to know better organization's current position before deciding new strategies. For example, it is useful to find out what's working well or where the company wants to go and how it might get there. So, it is a tool that can help the company to make future decisions.

As standard ISO 14001:2015 does not establish any particular methodology to analyse risks and opportunities of the organisation, it has been decided to use SWOT analysis to identify these factors.

Table 6. SWOT analysis of current GALVANIX situation. Source: Own elaboration.

Intern analysis	
Strengths	Weaknesses
Stability and good economic situation	Old factory facilities
Experienced workers	Lack of environmental knowledge from the employees
Great quality product	Inexistence of any environmental management
Extern analysis	
Threats	Opportunities
Eventually, no compliance of legal environmental requirements	Increase environmental awareness among employees and clients
Bad reputation due to lack of relation with residents in the area	Increase quality product and number of clients
Competitiveness in the market	Technology more efficient and environmentally sustainable

Information provided by the analysis will be useful in the project to define a strategy in the EMS to maximize strengths, overcome weaknesses, control the threats and benefit from the opportunities.

5.2 Organisation context

From this section onwards, it has been addressed the specific requirements of ISO 14001, which correspond to chapters 4 to 10 of the standard.

This section focuses on understanding the organization and its context, the needs and expectations of stakeholders, and determining the scope of the environmental management system. The description of the company can be seen in point '*4. Description and organisation of the company*', and the stakeholders and expectations in table 3 of section '*5.1.2 Identification of interested parties and its needs*'. On the other hand, the scope of the EMS is detailed below.

5.2.1 Scope

The scope defines the limits, physic and organizational, of the company. In other words, what the EMS is going to include and what is not included.

The EMS will include the *GALVANIX* factory where the activity is conducted, located on the area of *Mollet del Vallés*, and more specifically the following units:

- Activities directly related to the production process, such as degreasing and electrolytic bath, water wash and stirring, pickling, staining or water discharges, laboratory work, raw materials reception and transporting the product.
- Packaging process, product distribution, storages, offices, machinery room, and research and development activities.
- Business functions are also included in the EMS: more efficient infrastructure with less environmental impact, training employees about sustainable environmental practises in the workplace, suppliers from ecological sources and adequate environmental management of waste, emissions, water discharges from production process.

The EMS will not include:

- Other facilities not related to *GALVANIX* corporation, about whom *GALVANIX* does not have any control.
- Transporters and raw material production activities coming from third parties, not related or associated to the corporation.

5.3 Leadership

Commitment and leadership from top management of *GALVANIX* is a key factor to make the EMS implementation efficient and correctly. From this aspect, is also necessary the definition of an environmental policy and the responsibilities and authorities of the company.

5.3.1 Leadership and compromise

Employees and workers related to *GALVANIX* activity should be encouraged by management to implement and work with the new mechanics attached to the EMS. So, top management is going to demonstrate its commitment by:

- Assuming responsibility and accountability for the effectiveness of the EMS.
- Ensuring that environmental policy and environmental objectives established are realistic, measurable, achievable, in a feasible timescale and compatible with the direction and context of *GALVANIX*.
- Guaranteeing the integration of the requirements into organization business processes, the necessary resources required and intended results of EMS.
- Contributing to the effectiveness of the EMS by directing and supporting employees.
- Promoting continuous improvement.
- Ensuring objectives are achieved.

5.3.2 Environmental policy

Environmental policy is a public and written document where management from the company define the environmental compromises of the organisation and the actions to achieve them. Therefore, the environmental policy of *GALVANIX* is the following:

GALVANIX carries out its activity with the utmost respect for the environment and its surroundings. Created in 2005, it has high ethical standards, as its products are made with care and quality. Gaining each day, the confidence and respect of its employees and clients, GALVANIX is a reference in the galvanic market at Catalonian region

Aware of the environmental situation, in order to demonstrate its commitment to the protection of the environmental, GALVANIX is based on the following principles of action:

- 1- Ensure compliance with all environmental legal requirements.*
- 2- Compromise with continuous environmental performance improvement.*
- 3- Assign all necessary means and responsibilities to guarantee the achievement of the environmental objectives, designing processes that tend to minimize and prevent environmental impacts, producing a higher sustainable product.*
- 4- Reduce quantity of raw materials and energy used.*
- 5- Reduce the quantity of waste, emissions and noise generated.*

6- Attend to needs and suggestions from employees, general public and ecological corporations.

Finally, for ensure that the environmental policy is documented and implemented, it should be signed by the manager of *GALVANIX*.

5.3.3 Organisational roles, responsibilities and authorities

Responsibilities and authorities for relevant roles are assigned and communicated by top management. By doing this, responsibility is assigned in order to ensure the EMS conforms the requirements for the standard and to report the performance to management.

GALVANIX has 20 employees in total, 15 working on the production process and 5 working on administration, organisational tasks and laboratory. In the next figure, *GALVANIX* organization chart is described.

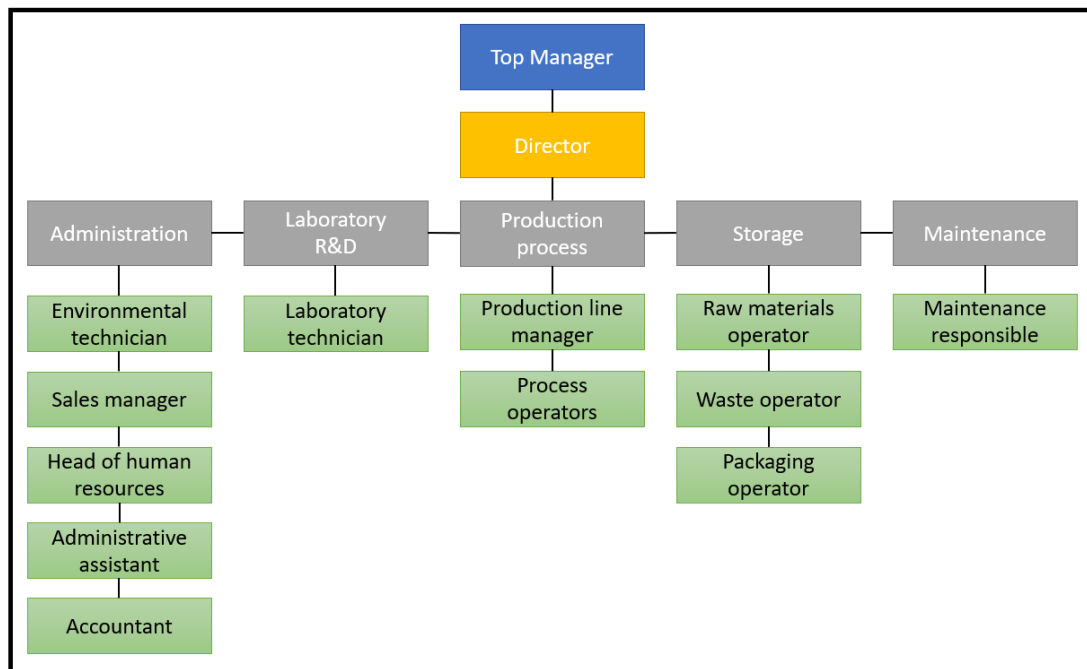


Figure 8. Organisational chart of *GALVANIX*. Source: Own elaboration

Environmental technician, as part of the administrative department, have the responsibility of making the EMS work and to be correctly established in *GALVANIX*. Furthermore, it has to report the performance of the EMS to top management. However, the environment field is very interdisciplinary, that is why the technician will cooperate with other departments and employees. Hearing advices of all the employees will make the EMS more context wise and adapted to the organisation, increasing the chances of success.

5.4 Planning of the Environmental Management System

The organisation will stablish, implement and maintain the processes need to meet the legal requirements and environmental objectives described below. Understanding the organisation is of uttermost important to address risks and opportunities efficiently. In addition, acknowledging

needs and expectations of interested parties is vital to develop a plan that suits all parties involved in *GALVANIX* activity.

On the other hand, the scope of the EMS defined is going to be used to determine the environmental aspects, environmental legal requirements and other issues, such as achieve continual improvement or assure the EMS can get its intended outcomes. Finally, actions for achieve the objectives of EMS, as well as addressing risks and opportunities, are described.

5.4.1 Environmental aspects

Within the defined scope of the EMS, it should be defined the environmental aspects of the organisation, regarding its activities, products and services, and their associated environmental impact. This requirement has been completed at section *5.1.4 Identification of significant environmental aspects*, where not only environmental aspects are described, but also indicators, reference values and the acceptable performance evaluation criteria for each aspect. In the following table, the environmental impacts associated to the environmental aspects are described.

Table 7. Environmental impacts associated with the environmental aspects of *GALVANIX*. Source: Own elaboration

Aspect class	Environmental Aspect	Environmental Impact
Atmospheric emissions	Greenhouse gases	Atmospheric pollution
	Particulate matter	Atmospheric pollution
	Combustion gases	Atmospheric pollution
Water discharge	DBO	Water pollution
	DQO	Water pollution
	Chemicals (Cu, Cr, Zn)	Water pollution
Natural resources consumption	Water consumption	Natural resources reduction
	Electricity consumption	Natural resources reduction
	Paper consumption	Natural resources reduction
	Plastic consumption	Natural resources reduction
	Raw materials consumption	Natural resources reduction
	Natural gas consumption	Natural resources reduction
	Chemicals consumption	Soil contamination
Hazardous waste	Chemical product packaging	Soil contamination
	Chemical waste	Soil contamination
	Machinery oil	Soil contamination
	Dirty rags	Soil contamination
	Old electronic equipment	Soil contamination

Aspect class	Environmental Aspect	Environmental Impact
Non-hazardous waste	Office Supplies	Soil contamination
	Broken containers of plastic, paper or glass	Soil contamination
	Organic waste	Soil contamination
Noise	Noise from machinery	Acoustic pollution
	Noise from offices	Acoustic pollution
	Noise from laboratory	Acoustic pollution
Emergency situations		
Accident	Accidental atmospheric emissions	Atmospheric pollution
	Accidental spills into waster	Water pollution
	Accidental dumping of waste	Soil contamination
	Chemical spill	Soil and water pollution
Fire emergency	Fumes of combustion generation	Atmospheric pollution
	Waste generation	Soil contamination

5.4.2 Environmental legal requirements

ISO 14001:2015 standard demands the organisation to determine and list the environmental legal requirements and other requirements related to the environmental aspects that applies to the corporation. It is also important to take into consideration that, as the company is located in Barcelona, the range of the requirements that have to be considered goes from Catalonia Government, to Spain and European Union.

Environmental legal requirements have been listed at the section of the project *5.1.3 Identification of the applicable environmental legal requirements*, during the Initial Environmental Review.

5.4.3 Environmental program: objectives, goals and actions

The environmental program is a useful tool to organise and execute the actions to achieve the goals set and obtain improvements continuously to the organisation. This part of the EMS to the second of the five steps mentioned during the introduction.

The organisation shall establish environmental objectives, goals and actions, taking into account the environmental aspects, associated compliance obligations and consider the risks and opportunities of the organisation.

The objectives should follow a SMART criteria, which means that they should be:

- Specific
- Measurable
- Achievable
- Result-oriented
- Time-limited

In the following table, it is shown the environmental objectives and actions with an estimation of the resources needed, charge of the responsible person, when it will be completed, and the indicators used to monitor every goal.

It is important to point out the meaning of the indicators used (which have been detailed in Table 5 at 5.1.4 *Identification of significant environmental aspects*) and the performance evaluation criteria, considering:

- Kr: Reference value from legislation
- K₁: Indicator average value from last year of a certain parameter
- K₂: Indicator average value from current year of a certain parameter

Table 8. Environmental programme objectives and goals with its actions, resources, responsibilities and indicators.
Source: Own elaboration

Objective: Minimize noise pollution				
Goal: Reduce 10% of noise pollution over the previous year				
Action	Resources	Responsible	Time scale	Indicators
<ul style="list-style-type: none"> - Install soundproofing material - Maintain warehouse door closed when there is no traffic 	600 € + public subsidy	Environmental technician	Starting: 1/2/2021 Monitoring: Every 3 months	K ₁ < Kr (K = level of dB)
Objective: Eliminate light pollution				
Goal: Eliminate light pollution to the surroundings during night time				
Actions	Resources	Responsible	Time scale	Indicators
<ul style="list-style-type: none"> - Adjust outdoor luminaire so it does not emit above the horizontal plane. 	90 € + Light technician	Maintenance responsible	Starting: 8/2/2021 Monitoring: Every year	Luminaire conditions complies with legislation

Table 8. Environmental programme objectives and goals with its actions, resources, responsibilities and indicators.				
Source: Own elaboration				
Objective: Minimize waste generation				
Goal number 1: Reduce 10% of solvents during production process				
Actions	Resources	Responsible	Time scale	Indicators
<ul style="list-style-type: none"> - Reuse solvents when possible - Recycle organic solvents 	Training and formation of process operator	Environmental technician	Starting: 15/2/2021 Monitoring: Every month	$K_2 \leq 0,9K_1$ (K= kg solvents / m ² of production)
Goal number 2: Reduce 5% of plastic and paper generation during packaging process				
Actions	Resources	Responsible	Time scale	Indicators
<ul style="list-style-type: none"> - Use of material efficiently - Reuse material when possible - Recycle 	Training and formation of packaging operator	Production line manager	Starting: 15/2/2021 Monitoring: Annually	$K_2 \leq 0,95K_1$ (K= kg paper and plastic / m ² of production packaged)
Goal number 3: Improve waste material organisation				
Actions	Resources	Responsible	Time scale	Indicators
<ul style="list-style-type: none"> - Label all waste - Organise waste to be covered - Install restraining system for waste solvents 	300 €	Environmental technician	Starting: 22/2/2021 Monitoring: Monthly	Waste material conditions complies with legislation
Objective: Minimize atmospheric emission				
Goal number 1: Reduce indirect atmospheric emissions				
Actions	Resources	Responsible	Time scale	Indicators
<ul style="list-style-type: none"> - Change combustible supplier 	100 € / annually (plus fee from the consumption)	Environmental technician and administrative assistant	Starting 22/2/2021 Monitoring: annually	$K_2 < K_1$ (K = CO ₂ / m ² of production)

Table 8. Environmental programme objectives and goals with its actions, resources, responsibilities and indicators.				
Source: Own elaboration				
Goal number 2: Improve measurement conditions				
Actions	Resources	Responsible	Time scale	Indicators
- Install platform to easily and safely measure from the focus emission spot	150 € + operator	Environmental technician	Starting: 28/2/2021	Comply with legislation
Objective: Minimize chemicals in wastewater discharges				
Goal: Reduce chemicals in wastewater discharges by 10%				
Actions	Resources	Responsible	Time scale	Indicators
- Apply electrocoagulation process to wastewater	1000 € + Water treatment company specialised on wastewater discharges for guidance	Environmental technician	Starting: 28/2/2021	$K_2 < K_1$ (K= concentration of a certain chemical in the wastewater discharge)
Objective: Minimize energy consumption				
Goal: Reduce energy used by 5%				
Actions	Resources	Responsible	Time scale	Indicators
- Install LED luminaire - Turn-off electronics during weekends.	200 €	Environmental technician	Starting: 15/2/2021	$K_2 \leq 0.95 * K_1$ K= kWh consumption/year

5.5 Resources, Communication and Responsibilities

Considering that the top management is determined to carry out the implementation of the EMS, it is going to provide the resources needed for the establishment, maintenance and continual improvement of the ISO 14001:2015.

Furthermore, is essential that workers are aware of different EMS parameters to make sure all organisation is working in the same direction. Accordingly, the environmental technician of the company, as the main responsible of the EMS, and with the cooperation of top management, is going to establish monthly theoretical formations to ensure internal communication about:

- Environmental policy of the company.
- Goals and objectives fixed.
- Environmental aspects and its impacts associated.
- Benefits of enhanced environmental performance.
- The implications of non-compliance with EMS and legislation requirements.
- Changes company is going to make during the EMS implementation.
- New responsibilities and work due to the EMS operational changes.

On the other hand, *GALVANIX* will also have external communication through an open dialogue with the public, authorities and other interested parties, including the local communities and the costumers. For this reason, the company will create an email for public attention, published on *GALVANIX* website and social media.

5.6 Performance evaluation

It is very important the organisation monitor, measure and analyse it is environmental performance. Monitoring helps to evaluate the effectiveness of the implemented standard through time and demonstrate, objectively, that the efforts made work.

5.6.1 Monitoring, measurement and analysis

During the IER and Environmental Objectives Programme are described indicators for each environmental aspect. However, in this section of the EMS those indicators have been described in terms on two values: (A) which indicates the consumption of a resource or generation of waste, and (B) which indicates de annual production of the company (being common for all the aspects) (Table 9).

Table 9. Indicators for the environmental aspects of the organisation. Source: Own elaboration

Environmental aspect	Annual consumption or generation (A)	Annual production (B)	Relation A/B
Energy	Annual consumption in MWh	m ² production of aluminium sheet	MWh/m ² aluminium sheet
Raw materials	Annual consumption in tons	m ² production of aluminium sheet	t of material / m ² aluminium sheet
Water	Annual consumption in m ³	m ² production of aluminium sheet	m ³ / m ² aluminium sheet

Environmental aspect	Annual consumption or generation (A)	Annual production (B)	Relation A/B
Waste	Annual generation in tons	m ² production of aluminium sheet	t of waste / m ² aluminium sheet
Greenhouse gases emissions	Annual emissions in tons of CO ₂ equivalents	m ² production of aluminium sheet	CO ₂ e/ m ² aluminium sheet
Noise pollution	Annual average in dB	m ² production of aluminium sheet	dB / m ² aluminium sheet

The organisation is going to ensure monitoring and measurements equipment are maintained and used appropriated, as well as evaluating the environmental performance and the effectiveness of the EMS. To do so, it will use the indicators described to evaluate, through time, the environmental improvement that provides the system. To know and demonstrate objectively the improvement, environmental aspects with its indicators can be compared between different years, to see the evolve and progression.

It is also really important *GALVANIX* communicate relevant environmental performance information, both internally and externally (as identified in its communication processes and required by its compliance obligations). Therefore, the company have to retain appropriate documented information as evidence of the monitoring, measurement, analysis and evaluation results.

5.6.2 Internal audit

GALVANIX is going to conduct internal audits annually to provide information with the objective to know whether the EMS conforms to the organization own requirements and the requirements of the standard ISO 14001:2015 (which this project is focusing on), and if it is effectively implemented and maintained.

The internal audit is going to be conducted by *GALVANIX* environmental technician and is going to evaluate every environmental aspect with the criteria established on objectives of the environmental program. The environmental technician has to ensure objectivity and impartiality of the audit process and report the relevant results to the top management.

5.6.3 Management review

Top management and the director of *GALVANIX* is going to review the organization's EMS, at planned interval of 6 months, to ensure its continuing suitability, adequacy and effectiveness. The process is going to include:

- Conclusions on the efficiency of the EMS
- Decisions related to continual improvement opportunities

- Decisions related to any need for changes to the EMS
- Actions, if needed, when environmental objectives have not been achieved
- Any implications for the strategic direction of the organization

Therefore, the management will have complete knowledge about EMS procedures, how is working and if any change is needed.

5.7 External audit: verification and validation

After the internal audit and approval of top management, the environmental technician of *GALVANIX* will search and hire a third party to verify the adequacy of the implemented EMS with ISO 14001 standard.

At this point, *GALVANIX* will has already prepared all the documentation and requirements regarding the standard and the legislation, which later will be reviewed by an external auditor. The external audit is an in-depth look at the management system, by a third party (to ensure impartiality), the purpose of which is to assess whether the business has all its processes and procedures in accordance with the ISO 14001 requirements.

The process consists about an on-site audit, where the auditor will interview the staff and review documented information about procedures, records monitoring, and all the documents that can be related to the EMS. This third party will verify conformance with the standard, and if the requirements are meet, *GALVANIX* will be rewarded with the official ISO 14001:2015 certificate, that will be valid for three years.

When the certificate for the EMS is acquired, the external auditor will perform every year a surveillance audit to see if *GALVANIX* is maintaining the system and continuing to meet the requirements of the standard. After three years, another registration audit is required to renew the certificate.

6. Conclusions

This Master Final Project addresses the problem of a fictitious company in the galvanic sector with a series of environmental shortcomings. In this content, it has been proposed the implementation of ISO 14001:2015 standard in order to control the environmental impacts related to the activity. Through this system, the company can improve its environmental performance, control the legal aspects and improve the processes to make them more sustainable, while improving the image of the company for its clients. Therefore, the main contribution of this work is the guideline provided, exemplifying how an EMS can be implemented in a company of galvanic sector.

It is true that the EMS requires plenty of time, economic resources and changes such as new concepts and ways to work for the employees. However, it has big benefits such as the

improvement of environmental performance, which should result on a reduction of the costs because of saving resources, and improved image towards interested parties and administration.

In addition, another highly relevant topic is the IER phase, without which it would be difficult to successfully carry out the system, since it facilitates to organize and manage efficiently the resources while saving future time and work for the company.

On the other hand, there are a huge number of environmental legal requirements that galvanic sector must accomplished. Failure to legal compliance can lead to administrative penalties, poor company image, and bad relationships with stakeholders. In the present work, it has been possible to identify and evaluate these legal requirements, which have been divided in five categories: atmospheric pollution, water pollution, waste produced, acoustic pollutions and light pollution.

During the description of the fictitious company, is observed a lack of organization and efficient practices related on environmental aspects such as atmospheric emissions or waste management, as well as the suboptimal usage of resources like water, energy or raw materials. Through the environmental program and thanks to the EMS, is believed these main problems are going to be solved and overall company performance is going to be improved. Furthermore, is important to mention employees are going to be trained to implement the new procedures to their daily work. In conclusion, ISO 14001:2015 is going to strength positive aspects of the company while solving and improving weaknesses.

The objectives of the work initially proposed have been met. The guideline of ISO 14001:2015 implementation and the Initial Environmental Review are successfully done, as well as describing the fictitious company (*GALVANIX*). Finally, as possible future work, the actual implementation of an ISO 14001:2015 could be considered in an actual real company of galvanic sector to demonstrate the veracity of the results.

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8. Acronyms and abbreviations

Environmental Protection Agency (EPA)

United Nations (UN)

Integrated Pollution Prevention and Control (IPPC)

Environmental Management Systems (EMS)

Eco-Management and Audit Scheme (EMAS)

Initial Environmental Review (IER)

Spanish association of Aluminium and Surface Treatment (AEA)

Wastewater (WW)

Atmospheric pollution (ATM),

Waste generation (WG),

Natural resources (NR),

Soil (SO)

Emergencies (EME)

Non-methane volatile organic compounds (NMVOCs)

Particles emissions (PM)

Reference value from legislation (Kr)

Indicator average value from last year of a certain parameter (K₁)

Indicator average value from current year of a certain parameter (K₂)

