

Case Report

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Case Study of the Application of a Methodology to Adopt Sustainability at SME Industries

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Article

Case Study of the Application of a Methodology to Adopt Sustainability

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Abstract: Companies around the world play an important role in the economic and sustainable development of the regions or areas where they participate. In particular, SME industries are a driver of the economy, social development and environmental care in Mexico, which is why it is necessary to identify how, from the business exercise, it is possible to positively impact its environment without losing its central objective, which is the generation of profitability. In this way, the purpose of this document is to show the development of the implementation of a methodology to adapt sustainability, from the economic, social, environmental and technological point of view, of an electronic components company located in the Northern Border Region of Mexico. Regarding its methodology, it is a five-step proposal: analysis, design, development, evaluation and standardization, being a complex process marked by iterative or cyclical steps. In the case study, special attention was paid to the development of strategy and implementation of indicators. The document highlights the supporting factors and the challenges experienced. While top management support, the presence of a project team and high employee involvement were identified as key supporting factors, the lack of dedicated resources and the lack of time to implement them exert a negative influence on the development process. The results presented here should help other SMEs in developing a sustainability adaptation methodology. In conclusion, the scientific discourse on sustainability adaptation, supporting factors and relevant challenges are added.

Keywords: sustainability; case study; industrial SME; sustainable manufacturing

1. Introduction

Given the emergence of Sustainability on the global agenda (WCED, 1987) and the growing demand for adaptation and its alignment with programs such as the Federal Attorney for Environmental Protection in Mexico, it has motivated companies as well as CEOs around the world to put it into practice and know its definition (Arvidsson, 2023). Sustainability in companies can be defined as “the adoption of business strategies and activities that meet the current needs of the company and its stakeholders, while protecting, maintaining and improving human and natural resources that will be needed in the future”. Regardless of the size of the company, adapting sustainability helps reduce resource use, save money and increase benefits for both society and employees [Aboelata, 2021; Ekins & Zenghelis, 2021; Le & Ikram, 2022]. Numerous scholars have highlighted the importance of sustainability management in SMEs [Cardoni, Zanin, Corazza & Paradisi, 2020; Das, Rangarajan & Dutta, 2020; Journeault, Perron & Vallières, 2021]. Incorporating sustainability into business activity improves their competitive position and also allows them to adapt to the value chain of large companies. SMEs occupy a key place in the Mexican economy, being 99.8% of the companies generating 72% of employment and 52% of GDP according to (IMCO, 2009), in turn, the manufacturing industry is the sector that contributes with a greater percentage to the GDP of Mexico with 20% hence the relevance of implementing said methodology in that sector (Statista Research Department, 2024) and in particular an SME in Chihuahua that is part of the Northern Border Region which includes the entities of: Baja California, Baja California Sur, Coahuila de Zaragoza, Chihuahua, Nuevo León, Sinaloa, Sonora and Tamaulipas (Fuentes et al., 2020).

2. Methodology

The following theoretical-methodological guide is proposed, the implementation of which firstly raises the Mission, Vision and Objective that consider sustainability (Table 1), and secondly the method Figure 1, which consists of five iterative stages, which must be carried out.

Table 1. Mission, vision and methodology objective.

Mission	Direct the company's activities towards sustainability adaptation.
Vision	Have a novel and efficient methodology to adopt sustainability in the company.
Objective	Create an environmental commitment from the company's management and employees.

The statement of the mission, vision and objectives with a theoretical consideration is based on the need for a change of thinking, since it requires effort and commitment to adopt sustainability in areas such as: investment, training and planning to adopt operational and structural changes; in this sense, Broo (2022) states that a new way of thinking is needed, that is, a revolution in culture and thinking to adopt sustainability because there are barriers that need to be broken, therefore, the commitment of management is important, and assigning a leading human resource for environmental care; in order to carry out and follow up on the methodology, for which it is necessary to establish a multidisciplinary team made up of all essential areas or departments. The methodological design of five iterative stages shown in Figure 1 and is explained below:

- **Analysis:** Before developing a sustainability management system, it is essential to carry out an analysis based on the measurement instrument proposed by Zapien (2018). Without a precise analysis, successful adoption is not possible. For this reason, it is also important to collect information about the company; processes it uses, both productive and administrative, installed equipment, products it generates, raw materials, waste generated in order to understand all operations and their interrelations, consumption of resources such as water and energy (Salieiev, 2024; Zhang, Ma & Yan, 2020). At the end of the analysis, a document will be obtained with practices that are carried out and those that are not, opportunities for improvement, and it will also have a process diagram of the inputs; raw material, water, electricity and gas, among others) and the output (scrap, emissions and water waste among others (Antonopoulos, Faraca & Tonini, 2021; Enyoghasi & Badurdeen, 2021). Likewise, an analysis of its value chain and a design analysis will be generated in order to observe where an eco-design can be implemented, finally, a portfolio or analysis of the implemented technologies will be carried out (Antonacci, Del Pero, Baldanzini & Delogu, 2022; Negri, Cagno, Colicchia & Sarkis, 2021).
- **Design:** Taking into account the requirements of the environment, which have been extracted from the initial analysis, the design of the actions to be carried out is carried out, generating options and evaluating their technical and economic viability, this can be helped by techniques such as cause and effect diagram, dispersion diagram, FMEA, SWOT (strength, opportunities, weaknesses and threats), Pareto diagram, Decision tree, ROI (return on investment) study as mentioned by Murphy et al., 2022, Obiuto et al., 2024, Patidar et al., 2024 and Vardopoulos et al., 2021; by establishing the feasible and most convenient actions due to the impact that could be generated, we proceed to identify the person in charge of the area or department that affects the implementation of the activities in order to have an instructional design with the activities and leaders or managers who will carry out said activity. As a previous step to developing the adaptation of sustainability, training is necessary for all company employees (Bilderback,

2024), highlighting the importance of adopting sustainability and the balance it achieves between society, the environment and the economy through the minimization of negative impacts on the environment, safe products and processes for employees, communities and consumers, of course considering economic profitability, if necessary, returning to the previous step of analysis to add information.

- **Development:** The development phase continues, in which the plan is executed. At this stage, the leader or area assignee plays an active role in carrying out the training and corresponding activities. Likewise, the human resource assigned to environmental care must have a Gantt chart to plan and schedule tasks in order to follow up on the practices or actions to be implemented (Alves & Putnik, 2022), in order to create procedures, generating a sustainable practices management system; this must be prepared for the evaluation phase.
- **Evaluation:** The evaluation seeks to determine what the flaws are at the analysis, design and development level. From these, we will return to the relevant phases to continue with the process again. When the person responsible for the methodology in the company approves this stage, we will continue with the standardization stage.
- **Standardization:** The standardization of processes is essential for the success of any business (Nilashi et al., 2023). Rodríguez (2017) mentions that the activity in small and medium-sized companies is undervalued and that the important thing is to carry it out in a manner appropriate to their needs. Firstly, it is important that all senior employees and those in the company's supervisory area participate in the documentation of the standard method to be followed. Owen (2020) states that it is important to understand the attributes of sustainability adaptation initiatives and to identify gaps in research and practice; it is also necessary that they receive and provide their employees with adequate and continuous training (Aboramadan & Karatepe, 2021); as well as the determination of performance indicators that quantify compliance or level of performance (Neri et al., 2021 & Zapien & Valenzuela, 2024); This quantification can be based on the following indices: GWP, MIPS, LCA, Ecological Footprint or performance rates. And finally, the action guidelines, which means stating the guidelines that those involved must take into account when carrying out the activities to achieve the objective.

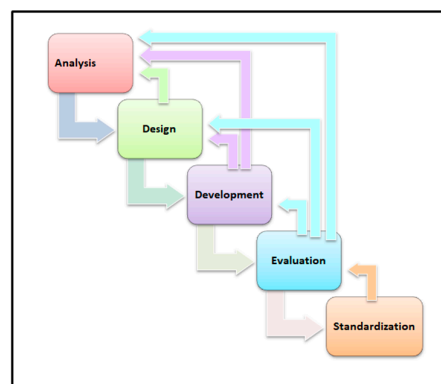


Figure 1. Methodological design for the adoption of sustainability focused on SME industries.

3. Case Study: Sustainable Management in an SME Industry

The focus of the case study was on a border city in Mexico due to the scientific contribution to the population of SME industries, and the methodological design is more appropriate due to the lack of sustainability adaptation in the industries of this city according to PROFEPA (2023) the industries certified in the voluntary clean industry program show only seventeen of these certified in the period 2022-2023.

The company in the case study is dedicated to the contract manufacturing of electrical, electronic and electromechanical products, harnesses and accessories; it is a company with around one hundred operational employees and twenty administrative employees, the number of employees increases and decreases depending on production, at the time of the study a nine-hour work shift was worked from Monday to Friday. The areas are divided into a pre-assembly or SMT area, which supplies three final assembly areas where more components are assembled and finally the final products are packaged as shown in Figure 2.

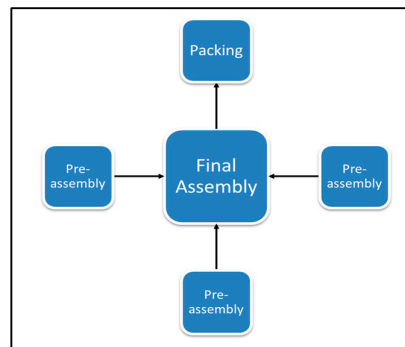


Figure 2. Operational Diagram.

Figure 3 shows the company's organizational chart, which consists of eight departments that serve customers, including local companies established with an IMMEX presence (Manufacturing, Maquiladora and Export Services Industry), making it part of the supply chain of international and large companies.

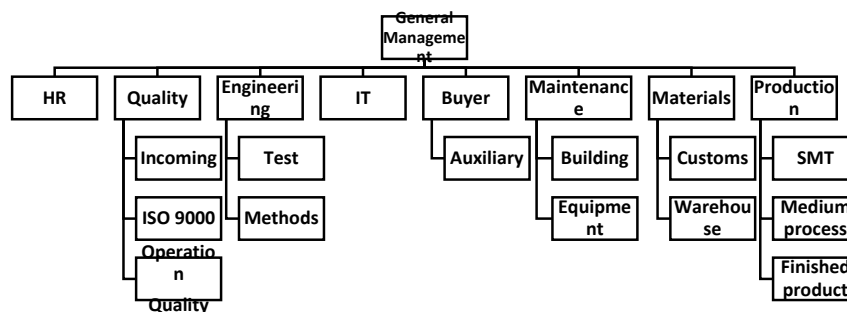


Figure 3. Organizational chart of the study company.

Due to the type of service and product it offers, the company studied belongs to the value chain of an international company; they are certified in ISO 9001, which is a quality management standard to continue being part of said value chain. Despite the above, none of the clients of the company studied have required an environmental certification. Below is the implementation of the proposed research methodology:

Analysis: The process flow diagram shown in Figure 4 shows on a large scale the general operation and main manufacturing activities of the company studied.

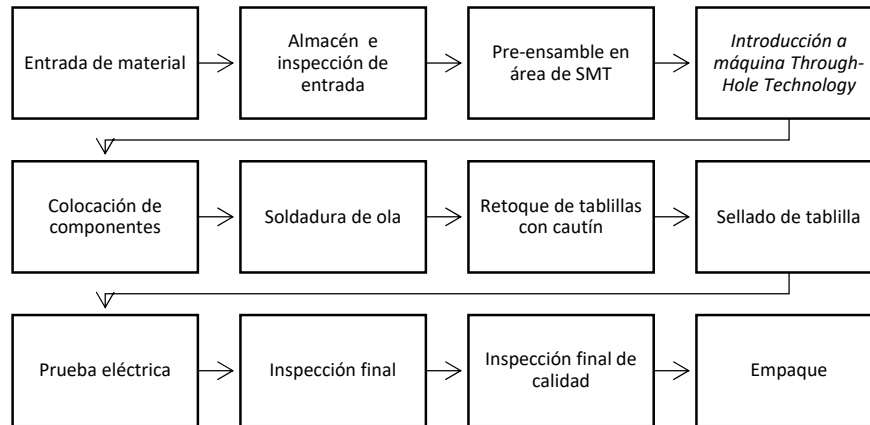


Figure 4. Diagram of basic functions of the company.

The diagnosis of the administrative process carried out, focused on environmental protection, is not clearly established, there is no policy or procedures; there is only a folder of studies, opinions and permits that is controlled by the Human Resources department; these are shown separated by dependency requirement, which is shown in Table 2. These requirements have been presented at the request of representatives of the aforementioned dependencies in order to avoid sanctions.

Table 2. Diagnosis of administrative process focused on sustainability.

Risk analysis generated by machinery (machinery emissions);	
Training and authorization for handling hazardous waste;	Secretaría de Trabajo y previsión social
Risk analysis for hazardous substances;	
Risk analysis for cutting and welding activities;	
Hermeticity study in natural gas lines;	
Thermography study;	
Lighting study;	
Noise study;	
Static electricity study.	Municipio
Land use permit;	
Contingency plan.	
Environmental impact report;	Secretaria de desarrollo urbano y ecología
Emissions study (non-machinery facilities);	
Hazardous waste registry;	
Solid waste collectors (Selicsa);	
Hazardous waste collectors (eco-service);	
Industrial recycling collectors (Yonke Fénix).	Secretaria del Medio Ambiente y Recursos Naturales
Registration as a waste generating company;	
Hazardous waste warehouse;	
List of authorized personnel for handling hazardous waste;	
List and map of hazardous waste containers;	
Safety data sheet for chemical products used;	
Authorization of companies for final disposal of hazardous waste.	

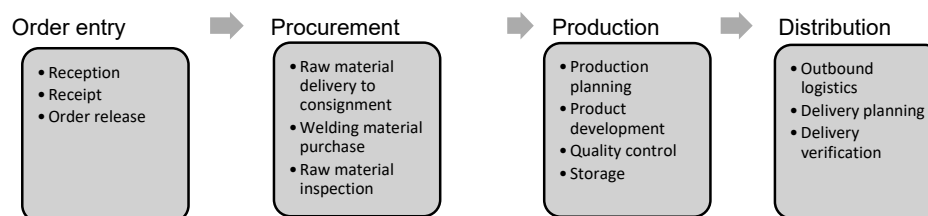
The installed equipment listed in Table 3 includes productive equipment and equipment used by human resources in general within the company.

Table 3. Equipment installed in the company.

Equipment	Quantity
SMT (Surface Mount Technology) machinery for surface mounting of electronic devices	4
Wave soldering machines	2
Sealing booths, with extractor tube	4
Electric soldering irons	45
Weller soldering smoke extractors	30
Ceiling extractors	2
Extraction hood	1
Computer equipment	26
T8 lamps	60
Electric heating	1
Washing air	1
Refrigeration / Heating in administrative area	1
Half-turn valves, in bathroom area	14
Non-saving tanks	19
Microwaves	9
Refrigerators	3
Coffee makers	3

The raw materials are mostly on consignment for the transformation and delivery of the final product to its clients, excluding the solder paste, liquid or in roll form, which in liquid form contains lead. The waste generated by its production process does not even amount to one percent of what is consumed, so it is always within the materials goal. The raw material components considered as waste are collected in the waste containers and are taken to the warehouse for final disposal by the electronic components recycler, to Ecoservicios del Norte SA de CV. Neither weight nor a detailed count of materials is obtained, because the company does not require it. The waste generated by soldering by soldering iron is entered as raw material for wave soldering machines. Other waste is from material packaging, among which are: wooden, cardboard and plastic pallets, which are stored by the materialists and transported by the recycling company Yonke Fénix SA de CV, with the exception of the foam, which is returned to the supplier for reuse.

The value chain shown in Figure 5 identifies the critical activities for the operation of the business, and details the critical processes that each of them entails. The general support activities are the administration of human resources and the general administration provided by the plant manager and majority investor.

**Figure 5.** Value chain analysis diagram.

After knowing the operation and functioning of the company, the inputs, consumption, installed equipment and waste generated; the next step is the analysis of sustainable practices, detailed in Table 4, and carried out according to the measurement instrument developed.

Table 4. Company evaluation with measurement instrument.

1 Monitors electricity use through a report.	<p style="text-align: center;">Not monitored as an environmental resource</p> <p style="text-align: center;">Cost/reading record.</p> <p style="text-align: center;">Power factor controlled.</p> <p style="text-align: center;">Motor peaks are controlled with capacitors.</p>
2 Monitors gas use through a report.	<p style="text-align: center;">Does not monitor</p> <p>Records gas usage from November to March, winter months.</p> <p style="text-align: center;">It has a hanging heater and a package heater.</p>
3 Develops energy and gas efficiency practices.	<p style="text-align: center;">Yes, it does practical work</p> <p style="text-align: center;">Assurance studies:</p> <ul style="list-style-type: none"> • Hermeticity of natural gas lines; • Thermography; • Lighting studies; • Static electricity. <p style="text-align: center;">Changing the lighting system from T12 to T8, changing ballasts from magnetic to electric.</p> <p style="text-align: center;">They have an electric freight elevator, which is no longer in use.</p>
4 Monitors drinking water use through a report.	<p style="text-align: center;">They do not monitor</p> <p>They do record daily readings in a logbook for security personnel, and comments that regulate extraordinary cases.</p> <p style="text-align: center;">Monthly consumption is recorded.</p> <p style="text-align: center;">Cost is not recorded.</p> <p style="text-align: center;">Greater use in the hot season due to garden irrigation.</p>
5 Knows the destination of its residual loads (drainage/causes).	<p>Yes, they know, it has a residual load permit, a residual water analysis and a technical opinion (Questionnaire for the application of residual loads).</p>
6 Develops water use practices.	<p style="text-align: center;">Yes, it carries out practices</p> <p style="text-align: center;">Leak verification by maintenance.</p> <p style="text-align: center;">It does not have a fire sprinkler system.</p>
7 Makes use of treated water.	<p style="text-align: center;">No, there is no facility or storage pool.</p> <p style="text-align: center;">The garden is watered with potable water</p>
8 Prepares a report on greenhouse gas CO2 emissions.	<p>No, there is no consolidated format. EH&S reports annual emissions from heating and emissions of other waste generated by the production process in the general extraction hood. The energy and gas consumed are not transformed into CO2 emissions.</p>
9 Identifies the sources of waste generation.	<p>No, there is a cafeteria service, so organic waste is not collected, and inorganic material is not separated for recycling (plastic, cardboard, aluminum, plastic lids) in the cafeteria or dining room.</p>
10 Maintains procedures for segregating organic and inorganic waste.	<p>No, there is a cafeteria service, so organic waste is not collected, and inorganic material is not separated for recycling (plastic, cardboard, aluminum, plastic lids) in the cafeteria or dining room.</p>
11 Maintains programs for re-using internal waste generated.	<p>No, there is no procedure for reusing material, although the reuse of solder slag generated by soldering irons is carried out without instruction or training on wave soldering machines.</p> <p>Production material is not reused, because it generates very little, but there is the opportunity to recover components from the boards, but they do not do it regularly unless they are short of material or it is expensive, so as not to exceed their goal.</p>

	Sheets are reused, ensuring the use of both sides; there is no procedure, but there is a tray near the main printer for their disposal.
12 Maintains a management plan for its solid waste.	Yes, if you have several management plans <ul style="list-style-type: none"> • Non-hazardous waste: <ul style="list-style-type: none"> • Recyclables • Domestic waste • Hazardous waste • Administrative waste
13 Monitors the amounts and type of waste generated through a report.	Yes, if monitored in monthly meetings by the materials manager, the financial goal is 1%. A digital record is kept by the ISO 9001 department.
14 Monitors what part of the waste (scrap) is recoverable.	Yes, if it is done: it is not accounted for or recorded internally, until the external company Ecoservicios reports the quantity.
15 Knows if the process/service generates toxic waste.	Yes, if it has risk studies <ul style="list-style-type: none"> -Safety and hygiene diagnosis -Risk analysis for hazardous substances (cutting and welding).
16 Identify the percentage of returnable packaging used by the total shipments.	Yes, if you do it in your packaging called Foam, antistatic separators, which are inside your boxes, these serve to protect the product from static, as well as from displacement.
17 Coordinate with your client to take the product to collection sites when it reaches its useful life.	No, there is an integration of that step into your supply chain.
18 Review a budget for investment in sustainable technologies or innovations.	No, it is not carried out. The return of non-hazardous waste (cardboard/plastics/pallets) is not specifically budgeted for environmental use.
19 Conduct a return on investment control for each of the sustainable technologies and practices implemented.	Yes, a technical evaluation is carried out by maintenance, but it does not consider specific environmental aspects, but rather projects that are carried out in general.
20 Collect and analyze the savings produced by the use of recycled materials, green energy, and recycled water, among other practices.	No, there is no record of this. Maintenance keeps a log of events that occur or installations that have been changed, to see changes or impacts on consumption.
21 Control economic inputs for the recovery or transformation of scrap or waste.	No, the process is not carried out: The scrap metric is available, it is counted to reach the goal, but it will not be compared with what is recovered.
22 Review technologies to ensure control of emissions or reduction of waste. E.g. Automatic shutdown of equipment after a prolonged period of non-use.	No, it does not perform a complete technology review.
23 Review technologies to reduce the amount of waste they generate.	No, it is not performed Preventive and corrective maintenance is not performed.
24 Review administrative processes that use paper, and could be replaced by an electronic database.	Yes, if they have a continuous improvement procedure, they do not have a sustainability rating.
25 Conducts eco-innovation projects in its products	Yes, if they have a continuous improvement procedure, they do not have a sustainability rating.

26 Conducts eco-innovation projects in its processes.	Yes, if they have a continuous improvement procedure, they do not have a sustainability rating.
27 Conducts eco-innovation projects in its organization.	No, I do not identify eco-innovation projects
28 Conducts training for company personnel on environmental care, recycling, toxic waste, environmental accidents, among others.	No, there is no specific training in environmental care, it is only handled on an annual basis:
29 Communicates the company's environmental behavior to its employees.	No, there are no environmental guidelines to be communicated.
30 Knows what percentage of its suppliers have a sustainable certification (clean industry/ISO 14000).	No, they don't know it, they are only required to have the certification according to their line of business in some cases if ISO 9001 is required.
31 Knows what percentage of its total products are recycled or reused at the end of their life cycle.	No, it is not unknown whether the customer of the final product that makes up the sub-assembly performs this operation.
32 Has identifications for being a green product (eco labels) if applicable.	No, it does not guarantee that the materials used are non-toxic, non-harmful or non-sustainable.
33 Knows what percentage of its customers are interested in having a sustainable certification (clean industry/ISO 14000)	No, he does not know this information
34 Conducts environmental actions in the environment of its company (reforestation, cleaning of parks or vacant lots, among others).	Yes, they do a noise study and reforestation of parks and gardens.
35 Coordinate with your client to take the product to collection locations when it reaches its useful life.	No, because it is a contract manufacturing company.

A design analysis was not performed, because the company receives the manufacturing requirement based on the design provided by the client. In general, what the engineers design at the plant are the test benches for continuity and voltage, and they also prepare master test tables for calibration or ensuring the operation of the test bench. The limitation of administrative resources, due to the fact that it is a medium-sized company, means that there is no resource dedicated to the sustainable approach; support to activate the next phase will be part of the human resources department.

Design: The list of suggested sustainable practices to be implemented presented in Table 5 was divided according to the approach, for a better visualization of impact, as well as to present to senior management and investors who can see the impact of sustainable adaptation. Each of these opportunities for implemented practices was directed to the personnel responsible for executing them.

Table 5. Evaluation by approach with measuring instrument.

Focus	Practice proposals
Energy efficiency	<p>Analyze energy flows in industrial processes to improve designs and minimize total energy use (electricity, gas or other energy sources).</p> <ul style="list-style-type: none"> • Design of switches, to divide areas such as; office bathrooms on the second floor. <ul style="list-style-type: none"> • Intensity flows in the dining area. • Connections with separate switches in the area where microwaves are installed in the dining room. <ul style="list-style-type: none"> • Benches to avoid peaks generated by installed equipment. <ul style="list-style-type: none"> • Optimize energy use. • Training and awareness of the use of computer equipment shutdown. <ul style="list-style-type: none"> • Training and awareness of the use of power switches. • Establish procedures for turning off machinery and equipment such as soldering irons or testing (double verification by security guards on their tours) • Proposal for a coffee maker area in office areas, to concentrate the installed household appliance equipment (refrigerators, coffee makers, heaters, microwaves). • Proposal for the installation of the Wattio smart thermostat, which can be programmed and controlled through a mobile application, an internet connection is required. <p style="margin-left: 40px;">Use of renewable energy.</p> <ul style="list-style-type: none"> • Evaluation of the use of solar panels for the industrial warehouse space, return on investment and cost benefit. <p style="margin-left: 40px;">Evaluate energy costs.</p> • Based on records, monitor which months have higher consumption and what are the potential causes (Ishikawa Diagram). <p style="margin-left: 40px;">Invest in cleaner energy technologies.</p> • In case of changing luminaires, which have electric ballasts, see the adaptation and purchase of T5 tubes to eliminate the installed T8s. The benefit in consumption is from 58 watts to 35 watts. <p style="margin-left: 40px;">Record and treatment of information.</p> <ul style="list-style-type: none"> • Record of energy consumption to convert it to CO2 emissions. • Raise awareness in the company based on energy consumption goals and abiotic materials such as water use.

Water use	<hr/> <p style="text-align: center;">Evaluate flow and supply.</p> <ul style="list-style-type: none"> • Non-saving toilets installed, reduce the amount of flushing by placing a mass inside it, such as a water bottle, to reduce the amount of liters per flush. <p style="text-align: center;">Evaluate costs.</p> <ul style="list-style-type: none"> • In the consumption record, an increase is detected in summer due to watering the garden of the facilities. <p style="text-align: center;">Invest in cleaner technologies focused on reduction.</p> <ul style="list-style-type: none"> • Washing faucets; half-turn, non-saving, in one minute of open faucet approximately 10 liters can be wasted, the ecological faucets with automatic closing or adjustable pressure from 5 to 13 seconds guarantee a consumption of 1.9 liters per minute. <p style="text-align: center;">Use of treated or recycled water.</p> <ul style="list-style-type: none"> • There is no contact with the purple line that contains recycled water from the city, by the water board. <ul style="list-style-type: none"> • Contact with JMAS to see the proximity of this and evaluate the long-term benefit based on high consumption generated in summer. <p style="text-align: center;">Avoid contamination of soil and residual water.</p> <ul style="list-style-type: none"> • Ensure that all processes that use water as an input are documented to ensure the disposal of contaminated water. <p style="text-align: center;">Record and process information.</p> <ul style="list-style-type: none"> • Record and communicate this to employees to make them participate in the savings (cost and water consumption). <hr/>
	Input/consumption efficiency

- Maintenance and safety of machinery and equipment in order to prevent contamination and regulate energy consumption.
- Perform predictive maintenance on installed equipment.
 - Evaluate energy consumption.
 - Computerized controls to reduce energy consumption.
 - Shutdown of computer equipment checked from the network, IT.
 - Dematerialization or digitalization of documents.
 - Digitalization of documents, detailed analysis of processes by department, use email with digital files to send information.
 - Minimization of productive hour-by-hour sheet space reports (put two reports on a single sheet).
 - Use of whiteboards to communicate production and use fewer sheets.
 - Contact a sheet recycler to collect and shred sheets that already have confidential information.
- Better technologies to improve manufacturing processes without contamination.
- Adaptation or installation of extraction hoods
- Ensure the use of filters in soldering iron processes, since no extractor has a fan filter to contain volatile material.
 - R&D in the organization, products and processes and organization.
 - Training on what Eco-innovations are (products, processes and organization).
 - Design for disassembly; in test boards generated
 - or for recycling,
 - or to reduce the use of inputs.

Formats were developed to evaluate the viability, in the case of practices that require investment, such as changing lights, deposits, saving keys, among others, the use of an Excel database is suggested to calculate the return on investment (ROI) presented in Figure 6, which is adapted to the circumstances of use and which can be presented so that the company's investors approve the implementation.

ROI	
Calculadora de Retorno de Inversión	
ROI= (Beneficio obtenido - inversión) / inversión	
Electricidad	Kw Costo
Agua	m3 Costo
Gas	m3 Costo
Inversión	30000
Beneficio Obtenido	\$ 34,713.90
ROI	0.16

Ejemplo	Watts	KWh	Total	Costo
60 luminarias T8 to Led	58 watts/hora	0.058	3.48	\$ 7.48
	35 watts/hora	0.035	2.1	\$ 4.52
				1.38 Diferencias en watts
				\$ 2.97 Diferencias en costo kwh
				\$ 6,942.78 Diferencias en anual

Nota : Retorno a menos de 5 años

2.15 Costo Kilowatt
52 semanas
9 horas
5 días a la semana
2340 TOTAL DE HORAS AL AÑO

Figure 6. ROI Excel database.

On the other hand, a format with instructions for the SWOT diagram presented in Figure 7 was developed to support prioritization and decision-making regarding the order of practices that should be implemented.

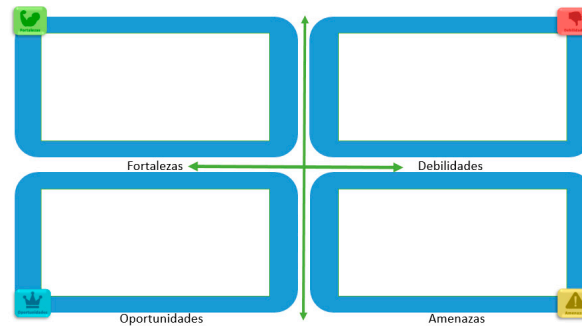


Figure 7. SWOT format.

Development: As part of the development, the human resources department will follow up on the improvement proposals. In order to follow up, a Gantt chart was developed. The proposals include: including a continuous improvement classification in the project registry, providing 6R training, standardizing material recovery processes and causes, training on computer equipment shutdown, installing a smart thermostat for switching on and off via Wi-Fi, among others; in turn, a biweekly review was established in the administrative meetings, as a first step, the establishment of environmental procedures was generated as well as training and training for the staff, on sustainability and its application in the company. Two different training sessions were held, one for administrative staff and another for operational staff, focused on the use of resources, recycling, use of printer paper, use of appliances, computer equipment shutdown, eco-design and eco-innovation among others.

Evaluation: The person responsible for the environment, which is a shared resource with human resources obligations, suggested that the approval of environmental procedures be granted by the Plant Manager, in order to generate the commitment of the company to the transition towards sustainability.

Standardization: The company, knowing the range of sustainable standard metrics, chose to adopt the carbon footprint measurement presented in Figure 8. This metric was selected in order to facilitate the presentation at staff meetings and to measure and report monthly the consumption of environmental resources and their impact on the environment. A sustainability manual was created with the guidelines for continuous training, training for staff in the care of the facilities and a report on improvements created by the Quality department.

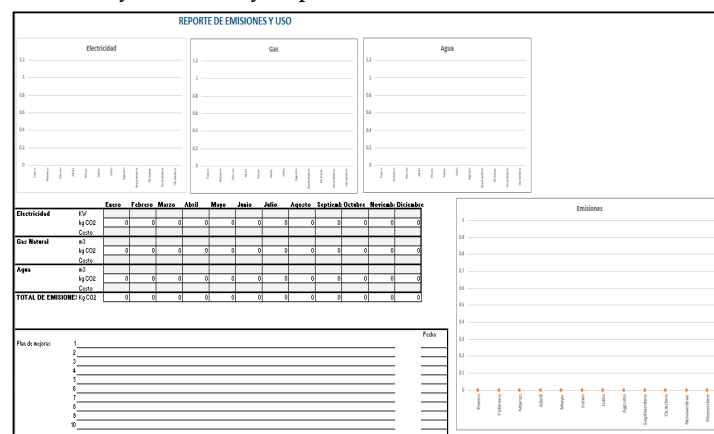


Figure 8. Carbon Footprint Report.

4. Discussion and Conclusions

One of the behaviors among SMEs according to Álvarez & Orozco (2019) is that they have fewer resources to be able to make commitments on sustainable development practices in their operation. This is the case study, which does not have an environmental department or resource. The activity of this area is assigned to the Human Resources Manager who performs multiple tasks and does not have assistants or technicians who could analyze, design, develop, evaluate and standardize the practices not carried out by the company that are on the list of suggested sustainable practices classified by focus in Table 5. Despite the competitive advantages offered by the application of these sustainable practices, there is a total lack of knowledge among business owners of the productive, financial and organizational benefits of the sustainable management system in general, such is the case of our case study where the general manager and investor of the company was unaware of the term sustainability and industry 5.0 and what it involves in the organization (Lewandowska, Berniak-Woźny, & Ahmad, 2023; Martins, Branco, Melo & Machado, 2022).

By having the commitment of the entrepreneurs and making them see that sustainability in manufacturing companies must occupy a concentric place within the objectives and mission of the organization; therefore, the productivity, quality and efficiency indicators must not be disconnected from the sustainability variables; thus guaranteeing greater responsibility in each of the links in the production chain and industrial ecology (De Batista et al., 2022; Hermundsdottir & Aspelund, 2021; Majeed et al., 2021; Tseng et al., 2021).

The most important practice that the company developed was sustainability and environmental awareness training, so that the staff knew and committed themselves together with management to transform the company's image and implement awareness and break paradigms, this by listing which actions with their collaboration will help promote environmental protection, ecological productivity, taking into account the profitability of the company and adding a sustainable adaptation model in their organization. The company decided that it was important to create an environmental procedures manual in order to obtain in the medium-term future the clean industry certification granted by the National Environmental Audit Program, to attract new clients by differentiating itself from its competition. To see sustainability as a gain and not a loss, the income from recycling materials will be allocated as a budget in favor of developing other sustainable practices.

The sustainability adaptation proposal in this research prioritizes a group of strategies to be developed as well as the metrics that are considered relevant to know the environmental impact. Subsequently, as a future plan, measurements are to be carried out to compare the scenario before and after implementing the methodology, to arrive at recommendations on technological and installation changes, taking into account the environment, to provide an environment that mitigates climate change, without leaving aside the traditional search for maximizing benefits as a guiding principle, in the face of this new social, environmental and economic paradigm. Likewise, it is intended that the sustainability evaluation be a cyclical process that has as its central objective the strengthening of the sustainability adaptation manual and the methodology used.

References

1. Aboelata, A. (2021). Assessment of green roof benefits on buildings' energy-saving by cooling outdoor spaces in different urban densities in arid cities. *Energy*, 219, 119514.
2. Aboramadan, M., & Karatepe, O. M. (2021). Green human resource management, perceived green organizational support and their effects on hotel employees' behavioral outcomes. *International Journal of Contemporary Hospitality Management*, 33(10), 3199-3222.
3. Álvarez Jaramillo, J., Zartha Sossa, J. W., & Orozco Mendoza, G. L. (2019). Barriers to sustainability for small and medium enterprises in the framework of sustainable development—Literature review. *Business Strategy and the Environment*, 28(4), 512-524.
4. Alves, C., & Putnik, G. D. (2022). Real-Time Management-Based Production Scheduling for Sustainability: An Introduction. In *Smart and Sustainable Manufacturing Systems for Industry 4.0* (pp. 45-64). CRC Press.
5. Antonacci, A., Del Pero, F., Baldanzini, N., & Delogu, M. (2022). Holistic eco-design tool within automotive field. In *IOP Conference Series: Materials Science and Engineering* (Vol. 1214, No. 1, p. 012045). IOP Publishing.

6. Antonopoulos, I., Faraca, G., & Tonini, D. (2021). Recycling of post-consumer plastic packaging waste in the EU: Recovery rates, material flows, and barriers. *Waste Management*, 126, 694-705.
7. Arvidsson, S. (2023). CEO talk of sustainability in CEO letters: towards the inclusion of a sustainability embeddedness and value-creation perspective. *Sustainability Accounting, Management and Policy Journal*, 14(7), 26-61.
8. Bilderback, S. (2024). Integrating training for organizational sustainability: the application of Sustainable Development Goals globally. *European Journal of Training and Development*, 48(7/8), 730-748.
9. Broo, D. G. (2022). Transdisciplinarity and three mindsets for sustainability in the age of cyber-physical systems. *Journal of Industrial Information Integration*, 27, 100290.
10. Cardoni, A., Zanin, F., Corazza, G., & Paradisi, A. (2020). Knowledge management and performance measurement systems for SMEs' economic sustainability. *Sustainability*, 12(7), 2594.
11. Das, M., Rangarajan, K., & Dutta, G. (2020). Corporate sustainability in SMEs: an Asian perspective. *Journal of Asia Business Studies*, 14(1), 109-138.
12. De Batista, M., Letieri Farias, M. M., Jankovic, V. V., & Mancini, C. M. (2022). Evaluación de sustentabilidad para sistemas ganaderos extensivos del sur de la provincia de Santa Fe.
13. Ekins, P., & Zenghelis, D. (2021). The costs and benefits of environmental sustainability. *Sustainability Science*, 16, 949-965.
14. Enyoghasi, C., & Badurdeen, F. (2021). Industry 4.0 for sustainable manufacturing: Opportunities at the product, process, and system levels. *Resources, conservation and recycling*, 166, 105362.
15. Fuentes, N. A., Brugués Rodríguez, A., González König, G., & Carrillo Viveros, J. (2020). El impacto económico en la industria maquiladora y en la región fronteriza del norte de México debido al alza de 100% del salario mínimo. *Región y sociedad*, 32-36.
16. Hermundsdottir, F., & Aspelund, A. (2021). Sustainability innovations and firm competitiveness: A review. *Journal of Cleaner Production*, 280, 124715.
17. IMCO (2024) INSTITUTO MEXICANO PARA LA COMPETITIVIDAD A.C.. Desarrollando las PYMES que Requiere México https://imco.org.mx/pymes_que_requiere_mexico/, recuperado el septiembre del 2024.
18. Journeault, M., Perron, A., & Vallières, L. (2021). The collaborative roles of stakeholders in supporting the adoption of sustainability in SMEs. *Journal of environmental management*, 287, 112349.
19. Küchler, R., Nicolai, B. M., & Herzig, C. (2024). A Novel Sustainability Management Tool for Small and Medium-Sized Food Manufacturers—Advantages and Improvement Opportunities. *mrev management revue*, 35(1), 35-65.
20. Le, T. T., & Ikram, M. (2022). Do sustainability innovation and firm competitiveness help improve firm performance? Evidence from the SME sector in vietnam. *Sustainable Production and Consumption*, 29, 588-599.
21. Lewandowska, A., Berniak-Woźny, J., & Ahmad, N. (2023). Competitiveness and innovation of small and medium enter-prises under Industry 4.0 and 5.0 challenges: A comprehensive bibliometric analysis. *Equilibrium. Quarterly Journal of Economics and Economic Policy*, 18(4), 1045-1074.
22. Majeed, A., Zhang, Y., Ren, S., Lv, J., Peng, T., Waqar, S., & Yin, E. (2021). A big data-driven framework for sustainable and smart additive manufacturing. *Robotics and Computer-Integrated Manufacturing*, 67, 102026.
23. Martins, A., Branco, M. C., Melo, P. N., & Machado, C. (2022). Sustainability in small and medium-sized enterprises: A systematic literature review and future research agenda. *Sustainability*, 14(11), 6493.
24. Martins, A., Branco, M. C., Melo, P. N., & Machado, C. (2022). Sustainability in small and medium-sized enterprises: A systematic literature review and future research agenda. *Sustainability*, 14(11), 6493.
25. Mendoza, O. G., & Galaviz, J. G. (2018). Análisis del desarrollo histórico de la industria maquiladora de exportación en México: caso de Ciudad Juárez, Chihuahua. *Revista Doxa Digital*, 8(15), 135-152.
26. Murphy, D. J., Raugei, M., Carbajales-Dale, M., & Rubio Estrada, B. (2022). Energy return on investment of major energy carriers: Review and harmonization. *Sustainability*, 14(12), 7098.
27. Negri, M., Cagno, E., Colicchia, C., & Sarkis, J. (2021). Integrating sustainability and resilience in the supply chain: A systematic literature review and a research agenda. *Business Strategy and the environment*, 30(7), 2858-2886.
28. Neri, A., Cagno, E., Lepri, M., & Trianni, A. (2021). A triple bottom line balanced set of key performance indicators to measure the sustainability performance of industrial supply chains. *Sustainable Production and Consumption*, 26, 648-691.
29. Nilashi, M., Keng Boon, O., Tan, G., Lin, B., & Abumalloh, R. (2023). Critical data challenges in measuring the performance of sustainable development goals: Solutions and the role of big-data analytics. *Harvard Data Science Review*, 5(3), 3-4.
30. Obiuto, N. C., Ebirim, W., Ninduwezuor-Ehiobu, N., Ani, E. C., Olu-lawal, K. A., & Ugwuanyi, E. D. (2024). Integrating sustainability into hvac project management: challenges and opportunities. *Engineering Science & Technology Journal*, 5(3), 873-887.

31. Owen, G. (2020). What makes climate change adaptation effective? A systematic review of the literature. *Global Environmental Change*, 62, 102071.
32. Patidar, A., Sharma, M., Agrawal, R., Sangwan, K. S., & Sarkar, P. (2024). Building supply chain resilience in developing economies: A weighted Ishikawa diagram approach. *Operations Management Research*, 17(1), 363-386.
33. PROFEPA (2023) Certificados Emitidos por el Programa Nacional de Auditoria Ambiental publicado el 31 de diciembre del 2023.
34. Rodríguez Naranjo, H. (2017). Propuesta de una metodología de producción más limpia en la división de pulpas y congelados de la Cooperativa Nacional de Productores de Sal en Limonal de Abangares.
35. Salieiev, I. (2024). Organization of processes for complex mining and processing of mineral raw materials from coal mines in the context of the concept of sustainable development. *Mining of Mineral Deposits*, 18(1), 54-66.
36. Statista Research Department (2024). El producto interno bruto de México – Datos estadísticos. <https://es.statista.com/temas/7764/pib-de-mexico/#topicOverview> revisado el 10 sept 2024.
37. Tseng, M. L., Tran, T. P. T., Ha, H. M., Bui, T. D., & Lim, M. K. (2021). Sustainable industrial and operation engineering trends and challenges Toward Industry 4.0: A data driven analysis. *Journal of Industrial and Production Engineering*, 38(8), 581-598.
38. Vardopoulos, I., Tsilika, E., Sarantakou, E., Zorpas, A. A., Salvati, L., & Tsartas, P. (2021). An integrated SWOT-PESTLE-AHP model assessing sustainability in adaptive reuse projects. *Applied Sciences*, 11(15), 7134.
39. WCED, S. W. S. (1987). World commission on environment and development. *Our common future*, 17(1), 1-91.
40. Zapien Guerrero, C. (2018). Sustainable management in the manufactures sme of Juárez city. *Instituto de Ingeniería y Tecnología. CIECONF - Proceedings in Scientific Conference*, 222-225.
41. Zapién, Cristina, and Valenzuela Facio Evelyn María (2024) . Indicators of Sustainability in Manufacturing. No. 11866. EasyChair, 2024.
42. Zhang, J., Ma, L., & Yan, Y. (2020). A dynamic comparison sustainability study of standard wastewater treatment system in the straw pulp papermaking process and printing & dyeing papermaking process based on the hybrid neural network and emergy framework. *Water*, 12(6), 1781.

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