DEVELOPMENT OF A MODEL FOR IMPROVING ENVIRONMENTAL ASPECTS IN AN AUTOMOTIVE COMPANY

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Abstract: This paper focuses on the analysis and evaluation of environmental aspects in the context of implementing the 8D methodology in order to reduce energy usage of an automotive Company in Romania. The main objective is to identify and implement efficient solutions to reduce energy consumption and minimize the impact on the environment. The paper analyzes the environmental aspects associated with energy use and production within the automotive company. The 8D methodology is a structured problem - solving process, and we explore how it can be applied to reduce energy usage. We present the key stages of the 8D methodology highlighting how they can be adapted and implemented within studied company to effectively address the environmental aspects related to energy consumption. Through a case study conducted at an automotive company in Sibiu we describe how the 8D methodology could be applied to reduce energy usage. Specific problems related to energy consumption were identified and analyzed, and effective corrective actions were developed to address them. In conclusion, this paper demonstrates the importance of environmental evaluation, the application of the 8D methodology, and the use of a structured process to address environmental aspects and reduce energy usage at an automotive Company from Sibiu, Romania. It provides a solid foundation for continuous improvement of environmental protection practices and energy efficiency within the organization.

Keywords: 8D methodology, environmental aspects

1. THE METHODOLOGY USED

The 8D method is generally used when the cause of a problem is unknown. The eight disciplines of the problem - solving process address problem elimination, from the

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initial description of the problem to preventing the cause of the problem from reoccurring. Effective problem solving relies on a disciplined approach and requires the involvement of experts from across the organization to solve them. The nature and extent of use of other 8D problem solving methods and tools will be determined by the problem solving team depending on the complexity of the problem [1,2]. 8D is one of these systematic methods used to tackle and solve problems.

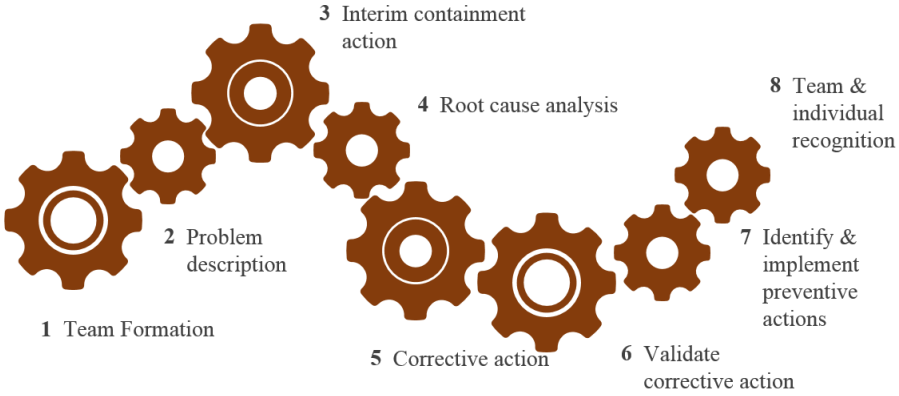

Fig. 1. 8D Problem Solving

The primary aims of the 8D methodology are to identify the root cause, correct and eliminate problems in a team approach, while making the problems solved useful in product and process improvement. [3] The 8D method is defined by 8 elements, called "disciplines" (Figure 1)

Implementing disciplines such as checklists, forms and techniques ensures constant progress. The first step is D1 - "Team Formation" where the teams need a good preparation. Establishing ground rules is essential. Implementing disciplines such as checklists, forms and techniques ensures constant progress.

The second discipline: D2 is called Problem description. The initial purpose of the 8D method is to describe the problem using data and pin it into specific categories for future comparisons. This approach uses the following means that have an important role in completing the process: 5 Whys, Fishbone, SWOT Analysis.

Before permanent corrective action is determined, an "Interim containment action" may be initiated which is temporary and is usually removed after permanent corrective action is taken. The root cause must be identified so that permanent measures can then be taken to eliminate it. This is the next step, shown in the figure above as Root cause analysis. Followed by 5 – Corrective action, stage that targets the main cause and can change the conditions of the product or process that were responsible for the problem and 6 Validate corrective action.

Discipline 7 provides the ability to preserve and share knowledge and avoid problems with similar products, processes, locations, or families. Updating documents and procedures/work instructions are expected in this step to improve future use.

2. CASE STUDY

2.1. Evaluation of environmental aspects

Since 2003, the location in Sibiu - Romania of the analysed automotive company has grown from 30 employees to approximately 4,000 employees. The success of this growth is due to the work contribution and collaboration of the employees. Continuing this success by focusing heavily on the five strategic reports: Quality, People, Competitiveness, Growth and Digitization. The company owns six modules for the manufacturing facility and three multi - story research and development buildings.

Updating the lists of environmental aspects and their associated impacts, as well as their centralization, is done annually or whenever changes occur such as:

- changes in technology;
- modernization or introduction of new installations, equipment, use of other raw materials, materials;
- the appearance of new requirements, regulations, demanding on the environment or the modification of the existing ones.

The assessment of environmental aspects is an essential component in the field of environmental protection, having the role of identifying and analysing the impact of human activities on ecosystems and human health. To facilitate this complex process, a valuable and effective tool is represented by the 2023 environmental assessment chart presented in Figure 2.

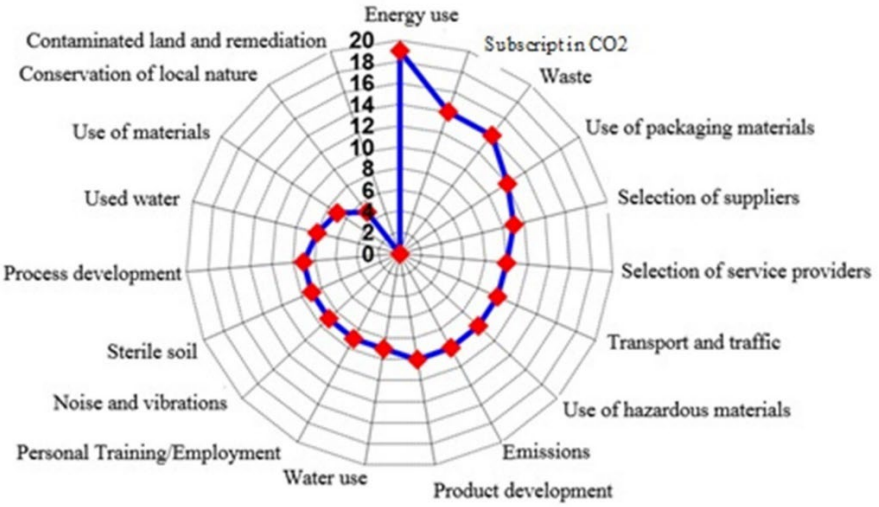

Fig. 2. Environmental aspects at Sibiu in 2023

In the figure above it can be seen that “Energy use”, “Subscript in CO2” and “Waste” are the main problems in Sibiu. The upside is that the “Contaminated land” value is zero.

2.2. 8D Report

The primary aims of the 8D methodology are to identify the root cause, correct and eliminate problems in a team approach, while making the problems solved useful in product and process improvement [2].

The environmental aspect can be summarized as: too much energy consumption (energy use).

2.2.1 Problem solving team (D1)

Teams need good preparation. Establishing ground rules is essential. Implementing disciplines such as checklists, forms and techniques ensures constant progress. The 8D should always have two key members: a leader and a champion/sponsor. The leader is the person who knows the 8D process and can guide the team through it (although they may not always have the best knowledge of the problem being studied). The champion or sponsor is the person who can make changes and give final approval to them.

The problem solving team consists of:

- QM - quality manager;
- RE - responsible for the environment;
- QT - quality technician;
- ET - environmental technician.

2.2.2 Description of the problem (D2)

The initial purpose of the 8D method is to describe the problem using data and pin it into specific categories for future comparisons. This approach uses the following means that have an important role in completing the process: 5 Whys, Fishbone, SWOT.

This step consists in summarize the problem and to give details of when and how often it occurs. The team could answer to the question “Is there any history that is relevant to the problem?” through the analysed of the evolution of energy use shown in the Figure 3.

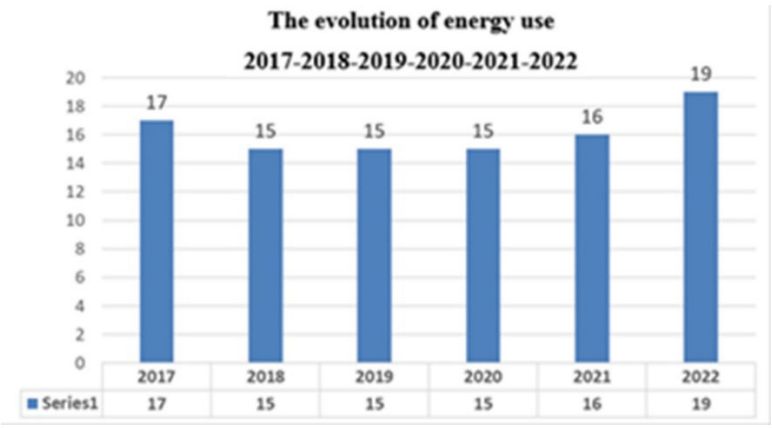

Fig. 3. Diagram of the evolution of energy use (average kw/h)

The reason for the increase in energy use is:

– The number of employees increases;
– Factory zoom;
– New lines;
– Obsolete technology.

2.2.3 Isolation actions (D3)

The interim containment action is temporary and is usually removed after permanent corrective action is taken.

At this stage the question is asked "Are there mitigation measures that can be taken?" In our case the answer is - Yes, these can be:

– Installation of photovoltaic panels;
– Wind turbines;
– Solar panels for hot water;
– Door automation;
– Illuminated access roads to sanitary facilities.

Temporary measures that can prevent the problem from worsening until a permanent solution is identified could be the following:

– Work from home (mobile work);
– Mandatory day at home per week;
– Temperature regulation;
– Switching off unused devices;
– Shutting off faucets and kitchen appliances;
– Employee awareness.

2.2.4 Analysis of the fundamental cause (D4)

The root cause must be identified so that permanent measures can then be taken to eliminate it. The team, list all possible causes of problems.

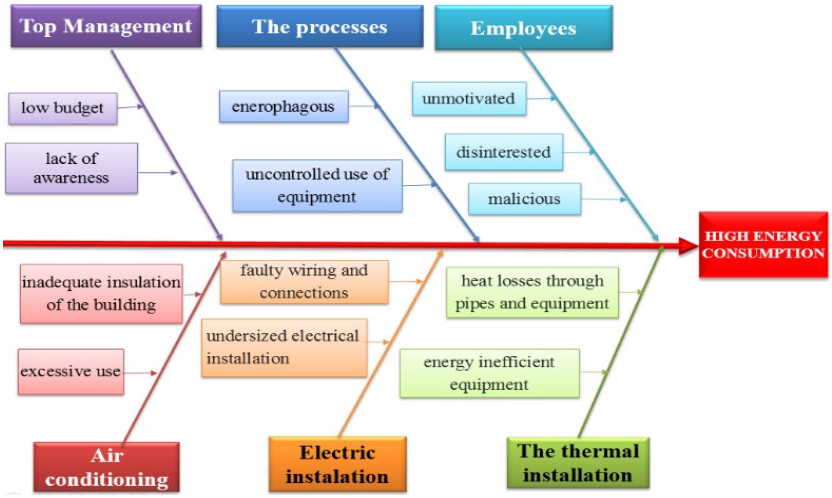

Fig. 4. Fishbone Diagram

In this case the team used root cause analysis techniques. The Ishikawa (Fishbone) diagram is meant to show the possible causes of a particular event or process. (Figure 4)

2.2.5 Selection and verification of corrective actions (D5)

This step targets the root cause and may change the product or process conditions that were responsible for the problem. "What permanent solutions could be implemented? Is there a deadline?" these where the questions that the team had to answer. The proposed alternatives were evaluated in relation to the impact on the problem and on the organization.

The following evaluation criteria were identified:

- Total cost – The cost must not exceed the available resources;
- Impact on the problem – The team estimated the impact of different alternatives on the problem;
- The cost/benefit relationship - these are considered important, but the cost of each alternative compared to its impact on the team's mission is even more important;
- Change resistance/impact – People are usually fearful when it comes to change. If all factors are equal, the option that will probably produce the least resistance is preferable;
- Implementation time – The team evaluated the necessary time and related it to the urgency of finding a solution;
- Uncertainty in relation to effectiveness – Even if a proposed improvement has a favorable cost/benefit ratio, it may not be a good solution, the uncertainty of the benefits may be high;
- Environment – No proposed improvement must endanger the health and safety of customers or employees. The impact must be at least neutral, if possible positive.

Notations used:
3 – very favorable impact;
2 – medium favorable impact;
1 – weak favorable impact.

Table 1. **Alternative selection matrix**

Cause	Alternative	Criterion							Total
		A	B	C	D	E	F	G	
Low budget for energy efficiency of production processes	**Implementing low-cost energy efficiency measures, such as optimizing production flows, adjusting the work schedule, thermal insulation of key areas**	**3**	**2**	**3**	**2**	**2**	**1**	**2**	**15**
	Accessing external financing or subsidy programs	2	1	2	3	1	1	1	11
	Reallocation of the existing budget in favor of energy efficiency	1	1	2	2	1	2	3	12

Cause	Alternative	Criterion							Total
		A	B	C	D	E	F	G	
Lack of awareness	**Implementation of a training and awareness program for employees regarding the efficient use of energy**	**2**	**2**	**2**	**3**	**3**	**3**	**3**	**18**
	Awareness campaigns and periodic training for employees	1	2	2	1	3	3	3	15
	Implementation of a monitoring and feedback system regarding energy consumption	1	2	1	3	1	3	3	15
Excessive use of air conditioning	**Implementation of an energy consumption monitoring system and the establishment of performance indicators**	**2**	**3**	**3**	**1**	**2**	**3**	**3**	**17**
	Implementation of internal policies and procedures to limit consumption	1	2	2	1	2	2	2	12
	Monitoring energy consumption and informing employees about the reduction objectives	2	2	1	1	3	2	1	12
Inadequate insulation of the building	**Improving the thermal insulation of buildings**	**2**	**3**	**3**	**3**	**2**	**2**	**2**	**17**
	Improving the safety and tightness of windows and doors	1	1	2	3	1	1	1	10
	Implementation of an equipment control and monitoring system	2	2	1	1	3	1	1	11
Energy - consuming processes	**Analysis and optimization of energy processes to reduce excessive energy consumption**	**3**	**2**	**3**	**1**	**3**	**3**	**3**	**18**
	Implementation of energy recovery solutions in processes	2	2	3	1	1	1	1	11
	The use of more energy efficient technologies in processes	2	3	3	1	1	1	1	12
Uncontrolled use of equipment	**Implementation of a control and monitoring system**	**3**	**3**	**3**	**2**	**1**	**3**	**3**	**18**
	Training and education of employees regarding the efficient use of equipment	1	1	2	2	3	2	2	13
	Implementation of internal policies and procedures to limit uncontrolled use	1	2	2	2	2	2	2	13
Faulty wiring and connections	**Identifying and adjusting energy consumption to avoid excessive charging**	**3**	**3**	**3**	**2**	**2**	**2**	**2**	**17**
	Carrying out periodic inspections and maintenance of the wiring	1	1	2	3	3	3	1	14

Cause	Alternative	Criterion							Total
		A	B	C	D	E	F	G	
	Implementation of a cable and connection performance monitoring system	1	2	2	2	2	2	2	13
Undersized electrical installation	**Employee motivation and involvement program in energy saving initiatives**	**2**	**2**	**2**	**3**	**3**	**3**	**2**	**17**
	Implementation of power management solutions to avoid excessive loading	1	1	1	2	2	2	2	11
	Use of power control technologies for load monitoring and adjustment	2	2	1	3	3	3	1	15
Unmotivated employees	**Education and awareness program to increase employees' interest in energy efficiency**	**3**	**3**	**2**	**3**	**3**	**2**	**2**	**18**
	Organization of training and instruction sessions to develop skills in the field of energy efficiency	1	1	1	1	1	2	3	10
	Employee involvement in the process of identifying and implementing energy saving solutions	2	2	2	3	2	2	2	15
Disinterested employees	**Implementation of a video monitoring system and reporting of inappropriate behavior**	**3**	**3**	**3**	**2**	**3**	**3**	**2**	**19**
	Communication and active involvement of employees in the energy efficiency process	2	2	2	1	2	2	1	12
	Organization of team-building activities and interdepartmental projects to increase employee commitment and involvement	2	1	2	2	3	2	1	13
Malicious employees	**Inspection and repair of faulty ducts and equipment**	**2**	**2**	**3**	**3**	**3**	**3**	**3**	**16**
	Development of clear policies and procedures regarding the use of equipment and energy	1	2	1	1	3	2	1	11
	Creating a positive work environment and promoting ethical and responsible values among employees	2	2	2	1	1	1	1	10
Heat losses through pipes and equipment	**The purchase of new equipment, adapted to current conditions**	**3**	**3**	**2**	**2**	**2**	**3**	**2**	**17**
	Inspection and repair of heat distribution systems to reduce losses	1	1	2	3	2	2	2	13
	The use of modern materials and technologies for thermal insulation	2	2	2	1	1	3	1	12

Cause	Alternative	Criterion							Total
		A	B	C	D	E	F	G	
Energy inefficient equipment	**Replacing inefficient equipment with more efficient models**	**2**	**2**	**3**	**3**	**3**	**2**	**2**	**17**
	Implementation of preventive maintenance programs to keep equipment in optimal condition	1	1	2	3	2	2	2	13
	Carrying out energy audits and identifying equipment that requires replacement or improvement	1	2	2	1	3	3	2	14

2.2.6 Corrective action, implementation and validation (D6)

To successfully implement lasting change, proper planning is essential. A project plan should include: communication, steps to completion, measurement of success and lessons learned.

In this stage, the team had to answer the following questions Describe the steps you will take. Who is responsible? When is the deadline? The answers were centralized in Table 2.

Table 2. **Implementation planning**

Cause	The selected solution	Resources	Responsive	Term
Low budget for energy efficiency of production processes	Implementation of low - cost energy efficiency measures, such as optimizing production flows, adjusting the work schedule, thermal insulation of key areas	1 Consultant specialized in energy efficiency 1 specialist in thermal insulation 1 process improvement specialist	project manager	6 months
Lack of awareness	Implementation of a training and awareness program for employees regarding the efficient use of energy	1 internal trainer training materials/course support	Responsible for the environment	continuous program
Excessive use of air conditioning	Implementation of an energy consumption monitoring system and the establishment of performance indicators	Monitoring equipment Energy consumption analysis software	Responsible for production	3 months
Inadequate insulation of the building	Improving the thermal insulation of buildings	Thermal insulation materials Human resources for construction and maintenance	Responsible for maintenance	6 months
Energy - consuming processes	Analysis and optimization of energy processes to reduce excessive energy consumption	2 Consultancy specializing in energy efficiency 1 electromechanical engineer	Electrical engineer	6 months

Cause	The selected solution	Resources	Responsive	Term
Uncontrolled use of equipment	Implementation of a control and monitoring system	1 automation and control system 2 IT specialists 1 automation engineer	Specialist in automa-tion and control	4 months
Faulty wiring and connections	Identifying and adjusting energy consumption to avoid excessive charging	Replacement equipment and materials 1 electromechanical engineer 1 electrician	Electrical engineer	2 months
Undersized electrical installation	Employee motivation and involvement program in energy saving initiatives	1 electromechanical engineer 1 electrician	Electrical engineer	3 months
Unmotivated employees	Education and awareness program to increase employees' interest in energy efficiency	Trainer specialized in personal development 1 energy consumption optimization specialist	Responsible for human resources	continuous program
Disinterested employees	Implementation of a video monitoring system and reporting of inappropriate behavior	Trainer specialized in personal development 1 energy consumption optimization specialist	Responsible for the environment	continuous program
Malicious employees	Inspection and repair of faulty ducts and equipment	1 monitoring and security systems specialist	Project manager	continuous program
Heat losses through pipes and equipment	The purchase of new equipment, adapted to current conditions	Equipment and repair materials Maintenance team	Responsible for maintenance	1month
Energy inefficient equipment	Replacing inefficient equipment with more efficient models	Budget for the purchase of new equipment 1 automation specialist 1 electrical engineer 1 electromechanical engineer, 1 IT engineer	Responsible for purchases	3 months

The improvement team must select the most important project from the 13 potential projects proposed, to start the improvement process. The following criteria were used to select the project:

A – Chronicity – The project must design a problem that occurs frequently, not a recent one;

B – Importance – After the completion of the project, obvious results must appear to justify the effort;

C – Duration – Projects must have a duration of less than one year;

D – Measure of potential impact – The impact must be measurable;

E – Urgency – A project can be urgent if it addresses a problem that makes the organization vulnerable to competition;

F – Risk – If there are known or potential risks, it is likely that the project will last, or even not achieve the expected results;

G – Possible resistance to change – It is good to choose the project that will probably encounter the least resistance;

H – The project must succeed – The first projects provide opportunities to learn and adapt the quality improvement process;

I – The problem must be measurable – No project will be started until we have the necessary data.

Table 3. **Solution selection matrix**

No	Cause	The selected solution	Selected criteria									TOTAL
			A	B	C	D	E	F	G	H	I	
1	Low budget for energy efficiency of production processes	Implementation of low - cost energy efficiency measures, such as optimizing production flows, adjusting the work schedule, thermal insulation of key areas	5	4	5	5	3	5	5	3	4	39
2	Lack of awareness	Implementation of a training and awareness program for employees regarding the efficient use of energy	3	2	1	3	4	5	5	5	5	33
3	Energy - consuming processes	Analysis and optimization of energy processes to reduce excessive energy consumption	1	2	2	3	4	5	5	5	5	32
4	Heat losses through pipes and equipment	The purchase of new equipment, adapted to current conditions	3	1	2	3	4	5	4	4	4	30
5	Faulty wiring and connections	Identifying and adjusting energy consumption to avoid excessive charging	2	2	3	4	2	2	4	5	5	29
6	Uncontrolled use of equipment	Implementation of a control and monitoring system	3	2	4	3	3	4	5	2	3	29
7	Disinterested employees	Implementation of a video monitoring system and reporting of inappropriate behavior	4	2	2	3	4	3	4	2	4	28
8	Excessive use of air conditioning	Implementation of an energy consumption monitoring system and the establishment of performance indicators	5	1	2	3	4	3	4	3	3	28
9	Unmotivated employees	Education and awareness program to increase employees' interest in energy efficiency	4	3	2	3	3	3	4	3	3	28
10	Undersized electrical installation	Employee motivation and involvement program in energy saving initiatives	4	4	2	3	2	3	2	5	2	27

11	Inadequate insulation of the building	Improving the thermal insulation of buildings	1	2	3	4	2	2	4	5	4	27
12	Malicious employees	Inspection and repair of faulty ducts and equipment	2	2	3	3	2	3	3	2	3	23
13	Energy inefficient equipment	Replacing inefficient equipment with more efficient models	1	2	3	2	4	1	2	2	3	20

2.2.7 Avoid repetition (D7)

D7 provides the ability to preserve and share knowledge and avoid problems with similar products, processes, locations or families. Updating documents and procedures/work instructions are expected in this step to improve future use. So, the team had to decide what measures can be implemented to prevent a similar problem? These measure could be:

- Replacing old and energy - inefficient equipment with newer, more efficient models;
- Annual training plan;
- Sustainability policies and commitments;
- Carrying out a detailed energy audit of the building;
- Ensuring adequate thermal insulation of the building;
- Energy consumption monitoring and management.

2.2.8 Completion and recognition of team success (D8)

Teams need feedback to reach a satisfactory conclusion. Recognizing both team and individual efforts and allowing the team to see the first and new status solidifies the value of the 8D process. [5] The last steps done by the "Implementing team were to:

- Express your appreciation;
- Organizing a meeting with the team and expressing sincere gratitude;
- Thank you note;
- Organizing a special meeting in which the appreciation of the entire team will be expressed;
- Sharing positive feedback;
- Development and growth opportunities.

This process helped to identify the root causes that contributed to the environmental impact in the automotive company analysed from Sibiu. By implementing specific solutions and by following a well-structured action plan, it were also possible to solve the other causes, obtaining positive results [5].

3. CONCLUSIONS

In conclusion, the implementation of energy efficiency measures at the automotive company in Sibiu had a significant impact on energy consumption and

associated costs. By optimizing production flows, adjusting the work schedule, thermal insulation of key areas and other similar measures, a more efficient use of energy and a reduction in excessive consumption was achieved.

The implementation of an employee training and awareness program had an important role in promoting the efficient use of energy in all activities carried out within the company. Employees were involved and motivated to adopt responsible practices in terms of energy consumption, thus contributing to the desired results.

The implementation of an energy consumption monitoring system and the establishment of performance indicators allowed a more effective monitoring of energy consumption and efficiency. This provided a clearer understanding of how energy is used in the various processes and made it easier to identify and correct inefficiencies.

Improving the thermal insulation of buildings has led to a reduction in heat loss and heating demand, leading to significant energy savings. Review and replacement of faulty wiring and connections eliminated energy losses caused by weak or damaged connections.

By identifying and adjusting energy consumption to avoid excessive loading, unnecessary consumption and associated costs were avoided. Also, the implementation of an equipment control and monitoring system ensured an efficient flow of energy and prevented the unjustified use of resources.

The program to motivate and engage employees in energy saving initiatives was a key factor in promoting a culture of energy efficiency within the company. Employees felt motivated to actively contribute to reducing energy consumption and were rewarded for the results achieved. Implementing an education and awareness program increased employee interest and commitment to energy efficiency, providing them with information and tools to adopt responsible practices and contribute to the company's energy efficiency goals.

Ultimately, these energy efficiency measures had a positive impact on the company, helping to reduce energy consumption, optimize costs and increase operational efficiency. Through their implementation, the company has demonstrated a strong commitment to sustainability and environmental responsibility, succeeding in obtaining economic advantages and contributing to the protection of natural resources.

Before the implementation of energy efficiency measures, the monthly cost of energy for the company in Sibiu was 10,000 monetary units (MU). After the implementation of energy efficiency measures, which included optimization of production flows, adjustment of the work schedule and other measures mentioned previously, the monthly cost of energy decreased to 8,000 UM. This means a cost reduction of 2,000 MU. Thus, cost optimization led to a 20% reduction (2,000 UM / 10,000 UM x 100) of the monthly energy cost.

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