Implementation of PowerApps for Automating Carbon Footprint Measurement in an Energy Sector Company

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Abstract. This study focuses on implementing PowerApps to automate and optimize the calculation of the carbon footprint at ABB, a company dedicated to industrial process automation in the mining sector. The implementation not only significantly reduced the time required for data collection and processing but also improved the accuracy of the results, thereby ensuring compliance with environmental standards established by current regulations. The research followed a quantitative approach, employing an applied quasi-experimental design. The study included data from 12 services across the company's areas involved. Through the collection and statistical analysis of the information, the department responsible observed a notable improvement, as the results showed that after the implementation, all services achieved a high rating in terms of efficiency and accuracy in the carbon footprint calculation process. This contributed to significant optimization in the management required to carry out the measurement.

Keywords. Automation, PowerApps, carbon footprint

1 Introduction

Currently, many countries have established policies requiring companies to recognize the impact of their business activities on the environment by estimating their carbon footprint. In some of these countries, such as Malaysia, according to [1], an ambitious goal has been set to reduce the intensity of GHG emissions by 45% by 2030, which includes an unconditional reduction of 35% and a conditional reduction of 10%.

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There are a large number of carbon footprint calculators in Norway; however, according to [2] some of these were designed for a specific purpose, such as schools, calculating costs and emissions from private driving, or as attachments to online banking services and shopping transactions, but at this point they are very general.

In Latin America, specifically in Argentina, 22% of companies that have signed the UN Global Compact measure their carbon footprint, and 19% of companies that have not signed it also measure their carbon footprint [3]. These results are being developed through its Climate Ambition Accelerator program.

2 Background

To strengthen our study, we consider authors who have previously addressed research related to ours, such as [5] with their research conducted in London, United Kingdom - A New Calculator to Calculate the Carbon Footprint of Fluorinated Gases Used in Vitreoretinal Surgery that highlights the great impact of hexafluoroethane and the challenge of clinics to measure their carbon footprint. Where they proposed the creation of an Excel sheet to simplify the carbon footprint calculations of retinal surgeons, for which it was proposed to allow the conversion of the gas using the modified ideal law gas formula at standard temperature and pressure (STP) for the smallest containers. The results showed that the use of large cylinders generated considerable gas waste due to their expiration, increasing CO2 emissions. However, it was observed that single-use 30 mL canisters significantly reduced emissions, even when considering their environmental impact in manufacturing and disposal. This highlights the importance of improving the visibility of the carbon footprint and taking steps to reduce its impact, aligning with the carbon footprint reduction strategies established by the NHS.

On the other hand, [6] with its research carried out in Castellón, Spain – Carbon Footprint Assessment Tool for Universities: CO2UNV addresses the difficulty of universities in calculating and communicating their carbon footprint, especially given the growing importance of sustainability in the context of international treaties.

They proposed to unify, standardize and promote its calculation in order to obtain results that allow identifying reduction opportunities. For which a tool called CO2UNV was developed and tested in Visual Basic for Application language of Excel. From this tool, it was possible to analyze the information, and a graph was created that shows the environmental and economic efficiency of each variable. Allowing the calculation of the carbon footprint of universities and is adaptable to other organizations and geographic regions. The results at the Universitat Jaume I showed a reduction in the carbon footprint, demonstrating the usefulness of the tool to identify critical areas, evaluate environmental improvements and carry out temporal monitoring, including reforestation offsets.

Regionally, as mentioned [7] in the research carried out in Quito, Ecuador - Estimation of carbon footprint for floriculture company ECOROSES SA based on the GHG Protocol methodology using a carbon footprint calculator where a problem related to the measurement of the carbon footprint in the floriculture sector was faced to improve its image in the international market. Where the main objective was to estimate the carbon footprint generated by the company's activities using an environmental calculator, applying an experimental and applicative approach. Using spreadsheets and the GHG Protocol, emissions were identified and quantified in the three scopes, highlighting that the main sources were fuel and electricity consumption. This made it possible to prepare an environmental diagnosis and propose strategies to reduce emissions, demonstrating the usefulness of digital tools in environmental management.

In addition, [8] conducted research in Medellín, Colombia - Development of a mobile and web application to calculate the carbon footprint in the education and transportation sectors, which presents problems due to the limited availability of tools that support the measurement of the carbon footprint in the institutional field since currently the calculators are aimed at people for individual use. The objective was to create an application and a web platform to calculate the emissions produced by companies in the transportation and education sectors, for which the SCRUM methodology will be applied for its design and implementation and technologies such as Microsoft .NET and Xamarin to develop a multiplatform application. The result was an easy-to-use interactive tool that collects data through surveys, calculates the carbon footprint and is adaptable to different contexts, also proposes its compensation through the planting of trees managed with ICT tools. The application, available on mobile and web platforms, improved the accuracy of the calculation and promoted environmental awareness.

At the national level, in 2020, the Ministry of the Environment (MINAM) created a digital platform for measuring carbon footprints and published the Guide for the Operation of the Peru Carbon Footprint Tool, within the framework of Law No. 30754 – Framework Law on Climate Change. The objective of the research was to establish a standardized procedure for calculating the carbon footprint, in order to strengthen environmental management at the organizational level. It used an application-based and normative methodology based on standards such as ISO 14064-1:2016 and the GHG Protocol to ensure the international compatibility of the measurement system. As a result, it implemented a digital platform that allows organizations to measure, verify, reduce, and neutralize their GHG emissions through a four-level recognition system. The tool also generates an emissions history by organization and economic sector, strengthening national climate monitoring and coordination with other systems such as INFOCARBONO and RENAMI. This initiative has significantly improved the environmental management of Peruvian organizations.

Among other studies, [9] carried out research in Lima, Peru - "Carbon footprint - GHG emissions due to the use of the lighting system of the Faculty of Environmental Engineering of the National University of Engineering, Lima-Peru" where he detected a problem in the infrastructure of his faculty linked to the inefficient use of its lighting systems. Given this, the objective was to partially establish the Baseline of the Carbon Footprint for the use of Lighting Systems in buildings. The methodology was of a quantitative type applied, based on the ISO 14064-1 standard, using a combination of direct measurement and calculations from activity data and official emission factors. The population included environments of the faculty, and the sample included 1,509 lamps distributed in 5 buildings. As a result, a total emission of 63,169 tons of CO_2 equivalent corresponding to the base year 2018 was identified, with academic activities being the ones that generated the highest consumption (41.18%). The research concluded that lighting represents a significant source of indirect (Scope 2) emissions, so efficient management is key to reducing the environmental impact in the education sector and contributing to the country's climate commitments.

3 Theoretical Framework

3.1 PowerApps Automation

Considering the purpose of this study, it is important to keep in mind the concepts, theories and studies that will provide us with the context and the necessary basis for its understanding and implementation.

3.1.1 Automation

It is defined as the use of technological tools and software to autonomously execute business operations and activities. This practice seeks to achieve specific organizational goals, which can range from manufacturing an item to human resource management or customer service. [10]

Business process automation is the main key to business transformation; it helps improve the performance of process components without losing their value and providing greater quality. It also has support in different technological tools to propose effective solutions: the main tools mentioned in this research are process automation software, use of RPA, AI technologies, information integration tools; as well as the use of cloud platforms and monitoring and analysis tools. For better results, it is recommended to use these tools effectively according to the needs and objectives of each company that begins to automate its business processes [11].

3.1.2 Development Environments

“An integrated development environment (IDE) is a software system for designing applications that combines common developer tools into a single graphical user interface (GUI)” [12]

According to [13], the importance of IDEs lies in that they provide a central interface of functionality for common development tools, format text, compile, and help in test automation and the debugging process.

As the developer writes methods and tests, the editor provides continuous code quality analysis and error detection. If no errors are detected, the editor compiles the updated methods. For languages that don't require compilation, this is skipped. In some implementations, the editor automatically deploys updated methods and tests to the cloud or does so at the developer's request. [14]

3.1.3 Low Code

In today's digital age, organizations need custom software to succeed, but traditional development can be slow and complex. Low-code platforms offer an innovative solution by making software development easier and faster, enabling more people to participate in digital transformation. [15]

To better define this concept [16] tells us that a Low-Code Development Platform provides a development environment that users can use to create applications through graphical interfaces and configurations as opposed to traditional programming also called “hand coding”.

3.1.4 Data integration

This process allows for the unification of information within an organization without excluding any available data sources. This provides a unified view of the data, which will be converted into valuable information for decision-making in the organization's various areas. To achieve efficient integration, it is important to establish strategies that map each challenge encountered and study each tool to choose the one that best suits the needs. It is also important to consider the steps for unifying the data. Likewise, there are various integration techniques and strategies that require different data sources and the objective to be achieved with the information generated. [17]

3.1.5 Power Platform

As an example of this type of platform, the development of this project proposes the use of software solutions, specifically Microsoft Power Platform, which comprises several integrated tools such as Power Apps, Power Automate, and Power BI [18]. Power Platform is fully integrated within Microsoft 365, enabling users to design and implement customized solutions aimed at simplifying and optimizing organizational processes through its suite of services. [19]

3.2 Carbon Footprint Measurement

3.2.1 GHG

One of the main GHGs is Carbon Dioxide (CO2), due to its high concentration in our atmosphere it does not allow the infrared radiation emitted by our planet after absorbing sunlight to escape, which causes the global temperature to rise. [20]

3.2.2 Carbon Footprint

According to [21], one way to assess the total impact of the emission of different greenhouse gases (GHG) is by using the concept of carbon dioxide equivalent (CO2e). This concept allows all GHG emissions to be represented in a single value, by converting the different GHGs into a common base, thus facilitating the understanding and comparison of their joint impact.

3.2.3 GHG Protocol

The footprint calculation for this study will be based on the GHG protocol, which rigorously classifies emissions into different scopes. Scope 1 covers direct emissions from assets owned or operated by the company. Scope 2 covers indirect emissions resulting from the generation of energy purchased by the company, such as electricity, heat, and power. Finally, Scope 3 covers all other indirect emissions generated throughout the company's entire value chain. This provides a framework for organizations to quantify, regulate, and communicate their carbon footprint. [22]

3.2.4 CO_2 equivalent (CO_2e)

The CO_2 equivalent is a unit that expresses the climate impact of different greenhouse gases in terms of carbon dioxide, thus facilitating the aggregation and comparison of emissions. This equivalence is based on selected criteria, such as the time horizon and type of metric applied (e.g., GWP100), and its interpretation depends on the context and objectives of the analysis. Therefore, it is essential to justify the approach used and be transparent about the equivalence basis, as the choice of different metrics can alter the relative importance of the reported emissions. [23]

3.3 Data quality

To obtain a carbon footprint measurement, it is important to consider the quality of the data to be used. ISO/IEC 25012 therefore raises the importance of data and its management. The notable characteristics are inherent data quality, which describes that data must be accurate, complete, consistent, credible, and timely; on the other hand, there is system-dependent data quality, which considers availability, portability, and recoverability; and finally, it is important to highlight that data must be accessible, compliant, confidential, efficient, accurate, traceable, and understandable. This standard applies to data in a structured format and will allow for an integrated view of these data. [24]

3.4 Compliance with laws

According to article 24 of Law No. 28611, "all human activity that involves constructions, works, services and other activities likely to cause significant environmental impacts is subject, in accordance with the law, to the National Environmental Impact Assessment System - SEIA" [25]

Therefore, for the comprehensive management of climate change, the quality and accuracy of the carbon footprint must be ensured, seeking to comply with these laws that the private sector must follow. According to Article 21 of Law No. 30754, mechanisms must be established for the exchange of information, consultation, and dialogue, guaranteeing the effective participation of interested parties. [26]

4 Justification

This study is theoretically justified because its development was based on articles from indexed journals related to calculating the carbon footprint in different areas. Furthermore, the contribution we propose will help other companies measure it efficiently. It is methodologically justified because the results we will obtain will be based on the information provided by the organization, which will be processed using licensed software. Since this is applied research, we will consider the collection of said data in a before-and-after manner. It is practically justified because the implementation of PowerApps will help ABB optimize the time it takes to measure its carbon footprint, obtain a more realistic result, and present its results in an organized manner.

5 Objectives

5.1 General Objective

- Implement PowerApps to automate the carbon footprint measurement process in an energy company.

5.2 Specific objectives

- Implementing PowerApps to Reduce Carbon Footprint Calculation Time in an Energy Sector Company
- Implementing PowerApps to improve the quality of carbon footprint reporting in an energy company.
- Implementing PowerApps to help with state carbon footprint compliance at an energy company.

6 Materials and methods

This study will be developed as applied research, according to [27] this type of research takes advantage of the knowledge acquired from fundamental research to achieve specific objectives. In other words, everything we know about a particular area to solve specific problems. In this case, the implementation of PowerApps will improve the efficiency of calculating the carbon footprint. It will be of quasi-experimental design because according to [28] "its main characteristic is the non-random assignment of the intervention groups" (p.) This is since the assignment group of this study will be the same in the pretest and in the post-test. This will be approached from a quantitative approach, which according to [29] is based on a method that uses logic and probability to analyze data accurately and objectively. This allows the researcher to make deductions beyond the initial data, confirming hypotheses and obtaining reliable and repeatable results. It focuses on measuring in a controlled and rigorous way, ensuring that the results are solid and can be replicated. Additionally, our research will be at an explanatory level, as explained by [30] since it seeks to determine the cause-and-effect elements of the phenomena of interest to the researcher. Our population will be composed of the data collected from 12 defined services from the different areas of the company, a sample will not be used, since all the data will be analyzed in its entirety. The technique chosen for data collection will be the survey, so we will use a questionnaire with 13 questions in MS Forms as an instrument. With the collected data, we will extract information from Excel and use SPSS25 as analysis software to prepare results. For the development of the solution, I used Scrum, organizing the project into short sprints that allowed iterating, testing, and adjusting functionalities continuously based on end-user feedback.

7 Ethical aspects

- The confidentiality of the information provided by the company has been considered in conducting this research.
- The data collected will be used only for specific research purposes and not for any other purposes.

- The development of this study is guided by a strict methodology that validates the veracity of the study.
- All communication related to this investigation will be transparent and honest.

8 Study Limitations

This study is limited by the low national references for similar studies; currently, carbon footprint measurement is a topic not widely used in our country. Additionally, access permissions to company information are a tedious process that must be requested by the company's legal department and the head of the process. On the technical side, the time and resources available for application development and testing are limited, which restricts the ability to make significant improvements.

9 Proposal Development

9.1 Powerapps application

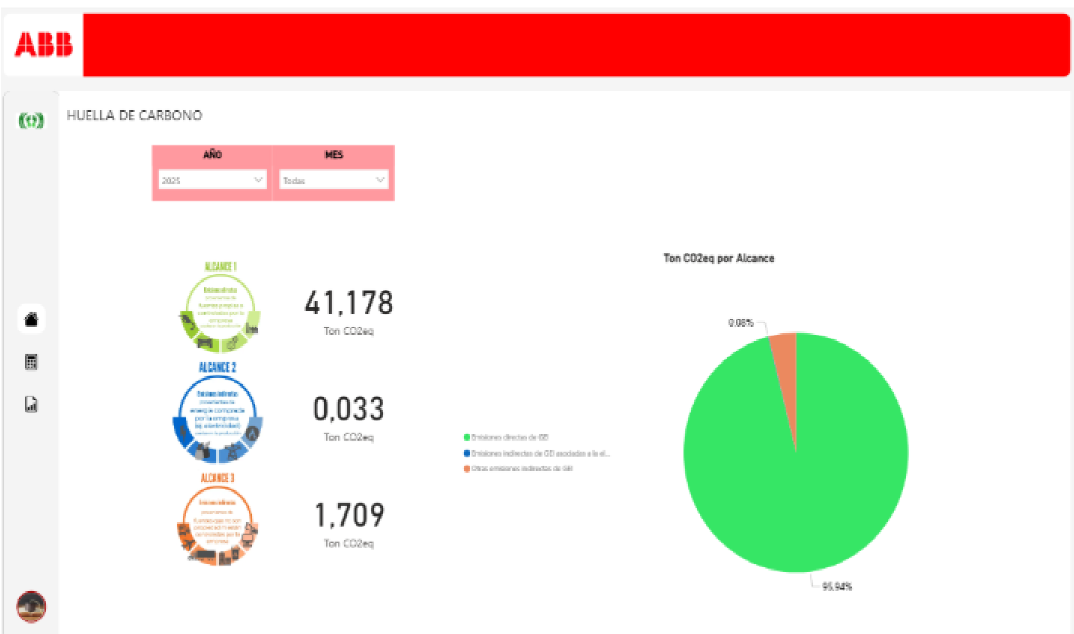

Fig 1. Home screen with key insights from the company data

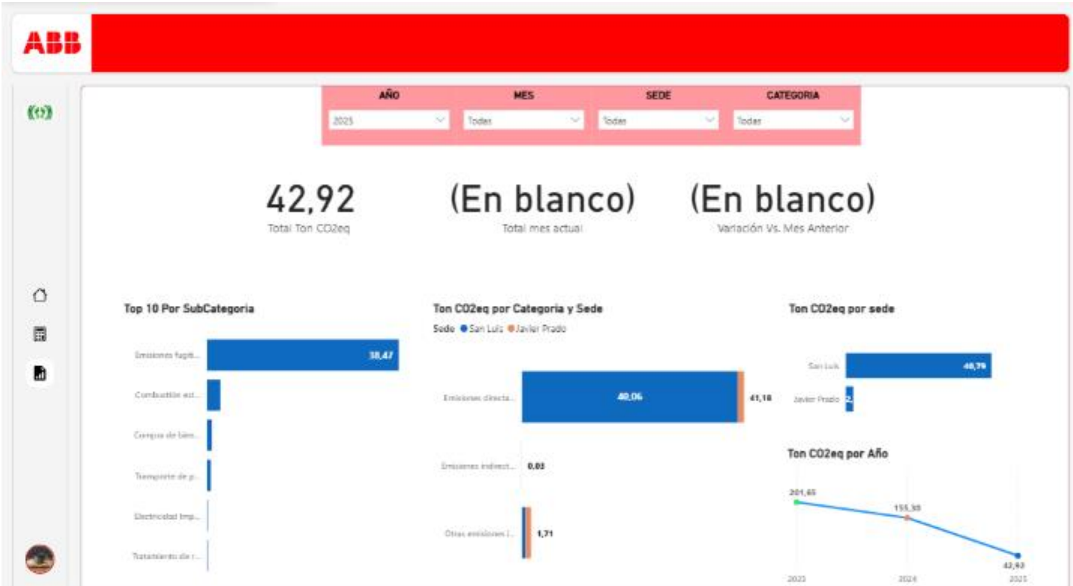

Fig 2. Carbon Footprint Report Screen with the Main Insights

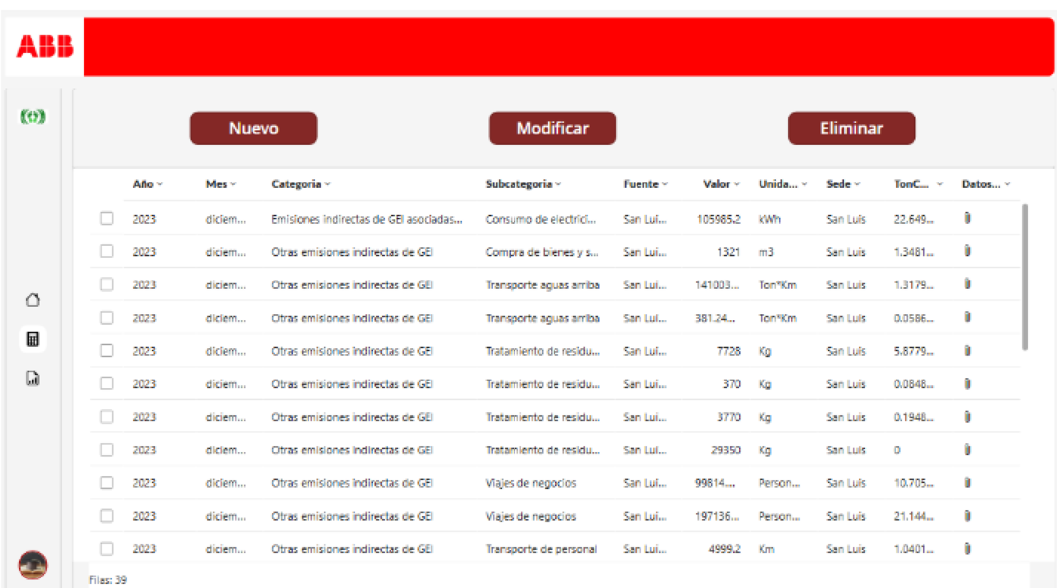

Fig 3. Data Management Module Screen for Emissions Records Administration

10 Results and discussion

10.1 Reliability Analysis

Pre-Test

Table 1. Cronbach's Alpha Pre-test Result

Reliability Statistics	
Cronbach's Alpha	***N items***
0.804	13

Interpretation: According to the results of the reliability analysis for the pre-test (Table 1), Cronbach's Alpha value of 0.804 indicates that the data has good reliability.

Post-Test

Table 2. Cronbach's Alpha Post-test Result

Reliability Statistics	
Cronbach's Alpha	***N items***
0.742	13

Interpretation: According to the results of the post-test reliability analysis (Table 2), the result of the post-test data is 0.742, which according to Cronbach's Alpha shows us that the data has ACCEPTABLE reliability.

We can demonstrate that, in both cases, thanks to Cronbach's Alpha analysis, the data used for this study are reliable for subsequent analysis of the results.

10.2 Descriptive Statistics

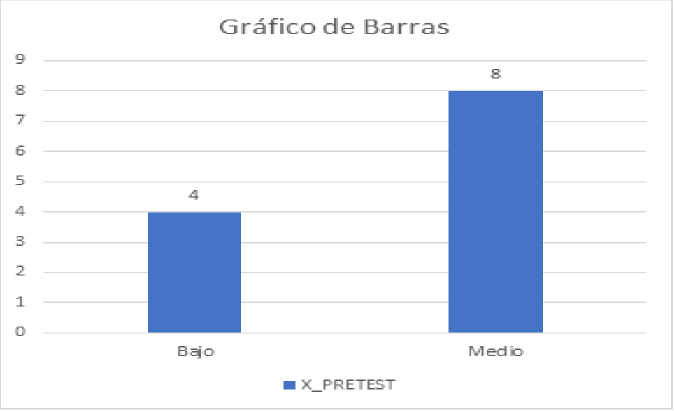

Fig 4. Crosstab Analysis Bar Chart

Table 3. Cross-Tab Analysis of Pre and Post Test Variables

		Table Head	X_Post	
			Alto	***Total***
X_PRETEST	Bajo	Recuento	4	4
		% del total	33,3%	33,3%
	Medio	Recuento	8	8
		% del total	66,7%	66,7%
Total		Recuento	12	12
		% del total	100,0%	100,0%

Interpretation: After applying the Scale to the data for all identified values and performing the Cross-Tabs analysis, **Table 3** shows that 33.3% of services had a Low rating and 66.7% a Medium rating in the pre-test. Furthermore, 100% achieved a High rating in the post-test, demonstrating an overall improvement.

10.3 Normality Test

For the normality test the following hypotheses were raised:

- H0: the data have a normal distribution
- Ha: the data do not have a normal distribution.

Data from the 12 services will be analyzed; given that the population is less than 50, we will use Shapiro-Wilk.

Table 4. Normality Analysis Results - Shapiro Wilk

	Table Shapiro-Wilk		
	Shapiro-Wilk	***gl***	***Sig***
C_H_Carbono_Pre	,907	12	,194
C_H_Carbono_Post	,873	12	070

As observed in **Table 4**, we conclude that since $p \geq 0.05$, we do not reject H0. That is, the data have a normal distribution, allowing for the use of parametric tests. However, since the population size is small (n=12), we will apply nonparametric statistics.

10.4 Inferential Statistics

The hypothesis test will be analyzed based on the results of the normality test, which concluded that nonparametric statistics will be used. Therefore, we will use the Wilcoxon test, which is ideal for the sample size of this study.

10.4.1 Testing the General Hypothesis

- **Ha**: Implementing PowerApps automates the carbon footprint measurement process in an energy company
- **H0**: Implementing PowerApps does not automate the carbon footprint measurement process in an energy company.
- **Significance value**: 0.05 (5%)

Table 5. Results of the Wilcoxon Analysis on the General Hypothesis

Test Statistics[a]	
	TOTAL POST- TOTAL PRE
Z	-3.074[b]
Sign. asin. (bilateral)	.002

a. Wilcoxon signed-rank test

b. It is based on negative ranges

Decision HG: **Table 5** shows a value of Z = −3.074, indicating a significant difference since the post-test values are higher than the pre-test values; and the significance level of 0.002 is less than 0.05, so we accept Ha and reject H0. This demonstrates that the implementation of PowerApps automates carbon footprint measurement.

10.4.2 Testing of Specific Hypothesis 1

- Ha: Implementing PowerApps reduces carbon footprint calculation time in an energy sector company
- H0: Implementing PowerApps does not reduce the time it takes to calculate the carbon footprint in a company in the energy sector.
- Significance value: 0.05 (5%).

Table 6. Results of the Wilcoxon Analysis Specific Hypothesis 1

Test Statistics[a]	
	Tiempo Calculo – POST- Tiempo Calculo – PRE
Z	-3.088[b]
Sign. asin. (bilateral)	.002

a. Wilcoxon signed-rank test

b. It is based on negative ranges

Decision HE1: **Table 6** shows the value Z = −3.088, which indicates a significant difference since the post-test values are higher than the pre-test values; and the significance level of 0.002 is less than 0.05, so we accept Ha and reject H0. This shows that implementing PowerApps reduces the time required to calculate the carbon footprint.

10.4.3 Testing of Specific Hypothesis 2

- Ha: Implementing PowerApps improves the quality of carbon footprint information in an energy sector company.
- H0: Implementing PowerApps does not improve the quality of carbon footprint information in a company in the energy sector.
- Significance value: 0.05 (5%)

Table 7. Results of the Wilcoxon Analysis Specific Hypothesis 2

Test Statistics[a]	
Calidad Medida – POST- Calidad Medida – PRE	
Z	-3.133[b]
Sign. asin. (bilateral)	.002

Decision HE2: **Table 7** shows a value of Z = −3.133, indicating a significant difference, as the post-test values are higher than the pre-test values. The significance level is 0.002; this value is less than 0.05. We therefore accept Ha and reject H0. This demonstrates that implementing PowerApps improves the quality of carbon footprint information.

10.4.4 Testing of Specific Hypothesis 3

- Ha: Implementing PowerApps helps with state carbon footprint compliance at an energy company 2024
-
- H0: Implementing PowerApps does not help with compliance with state carbon footprint laws in an energy sector company 2024
- Significance value: 0.05 (5%).

Table 8. Results of the Wilcoxon Analysis Specific Hypothesis 3

Test Statistics[a]	
Cumplimiento Leyes – POST- Cumplimiento Leyes – PRE	
Z	-3.213[b]
Sign. asin. (bilateral)	.001

a. Wilcoxon signed-rank test

b. It is based on negative ranges

Decision HE3: Table 8 shows a Z value of −3.213, indicating a significant difference since the post-test values are higher than the pre-test values; and the significance level is 0.001; this value is less than 0.05, so we accept Ha and reject H0. This demonstrates that implementing PowerApps helps with compliance with state laws.

Based on the results obtained, we have been able to demonstrate compliance with the objectives set. We have shown that implementing PowerApps to automate the carbon footprint measurement process reduces calculation time, improves measurement quality, and helps ensure compliance with state regulations.

It should be noted that, when comparing our results obtained on the carbon footprint calculation time in validation with [7], it was possible to identify that they agree with the results obtained, improving the estimation of the carbon footprint, benefiting the planning of strategies.

On the other hand, our results related to measurement quality have shown that automation with PowerApps improves the quality of the measurement and the generated reports, since we eliminate the human factor, managing to reduce calculation errors. As mentioned by [31], the benefits of automation include on-site and off-site connectivity, better collaboration, data sharing and communication, improvements in workflow (accuracy, reliability, transparency and more efficient acquisitions).

Furthermore, our results regarding compliance with state laws in validation with [32] were able to align with the objectives of the company and the State, allowing leaders and analysts, with extensive knowledge, to transform their business vision with the help of technologies.

Finally, the results obtained have significantly helped the company ABB in its process of calculating its carbon footprint since, implementing automation in manual processes reduces variability and improves efficiency.

11 Conclusions

Through this study, PowerApps was implemented to automate the carbon footprint measurement process in a company in the energy sector. This proved to be an effective strategy for improving manual processes into digital ones and optimizing the company's environmental management of its carbon footprint. This solution facilitates data traceability, generating significant improvements in carbon footprint calculation efficiency and measurement accuracy, promoting a culture focused on sustainability and compliance with government regulations.

Regarding the first specific objective, implementing PowerApps reduced the time it takes to calculate ABB's carbon footprint, which not only translates into resource savings but also increases the ability to respond to new external and internal requirements. This allows us to generate value in terms of efficiency by freeing up staff time and eliminating operational redundancies.

Regarding the second specific objective, implementing PowerApps to improve the quality of carbon footprint information at a company in the energy sector resulted in more reliable reports, minimizing human error, which strengthens the validity of the information provided. All of this translates into improved decision-making capabilities, as it allows us to consult historical information on calculations, enabling the user to analyze the evolution of the results.

Regarding the third specific objective, implementing PowerApps to assist with compliance with state carbon footprint laws in an energy sector company allows the company to better comply with current environmental regulations, led by Law No. 30754 – the Framework Law on Climate Change, which encourages companies to measure, report, and reduce their GHGs. This has contributed to strengthening regulatory compliance and institutional transparency, as the information generated allows for the establishment of strategies that allow the company to take timely action.

All the above demonstrates that the adoption of digital tools like PowerApps not only optimizes internal processes but also contributes to business sustainability and alignment with regulatory standards, representing a strategic advantage for companies. In this sense, future research can explore the impact of other emerging technologies on environmental management and digital transformation in different industrial sectors.

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