ISSN: 2723-9535

Available online at www.HighTechJournal.org

HighTech and Innovation Journal

Vol. 6, No. 3, September, 2025

Achieving Carbon Neutrality: Strategies in Organizations, Engagement and IT Innovations

Chan Rou Qian [1], Rajermani Thinakaran [1*], Richard Pravin Thomas Adisan [2], Tarik A. Rashid [3], Sharmila Devi Ramachandaran [4], László Koloszár [5]

[1] *Faculty of Data Science and Information Technology, INTI International University, Nilai 71800, Malaysia.*

[2] *School of Chemical and Energy Engineering, Faculty of Engineering, Universiti Teknologi Malaysia, Skudai, Johor, Malaysia.*

[3] *Computer Science and Engineering Department, University of Kurdistan Hewlêr, Erbil, Iraq.*

[4] *Faculty of Business and Communication, INTI International University, Nilai 71800, Malaysia.*

[5] *Alexandre Lamfalussy Faculty of Economics, University of Sopron, Sopron 9400, Hungary.*

Received 08 February 2025; Revised 10 July 2025; Accepted 03 August 2025; Published 01 September 2025

Abstract

This study examines the challenges organizations face in achieving carbon neutrality by analyzing employee awareness, organizational practices, and the role of information technology (IT). It aims to (1) assess employee engagement in sustainability initiatives, (2) evaluate the effectiveness of organizational policies in promoting carbon neutrality, and (3) explore the potential of IT solutions in reducing emissions. A mixed-method approach was used, combining questionnaires and interviews to capture quantitative and qualitative insights. Employees from various industries were surveyed to assess their awareness, while interviews provided deeper insights into organizational strategies and IT adoption. Statistical and thematic analyses identified key gaps and opportunities. The study reveals that limited employee awareness hinders sustainability efforts, emphasizing the need for targeted engagement programs. Organizational effectiveness in achieving carbon neutrality varies, with standardized policies and dedicated sustainability teams playing a crucial role. IT adoption levels differ, but data analytics and emerging digital technologies demonstrate strong potential for optimizing carbon reduction strategies. This research integrates organizational, technological, and behavioral perspectives, highlighting the importance of employee engagement and IT solutions in sustainability efforts. It provides actionable insights for organizations seeking to implement effective carbon neutrality strategies.

Keywords: Carbon Neutrality; Employee Engagement; Information Technology; Organizational Practices; Net Zero Emissions.

1. Introduction

In 2021, increasing global greenhouse gas (GHG) emissions to 36.3 gigatons necessitates immediate action [1]. The consequences of heightened GHG emissions, particularly carbon dioxide, contribute to global warming and the myriad impacts of climate change. Various international agreements and conventions, such as the Paris Agreement and Sustainable Development Goals (SDGs), underscore the global commitment to addressing climate change [2, 3]. In 2021, GHG emissions reached a record high of 36.3 gigatons, indicating a 6% increase from the pandemic-influenced low of 2020 [4]. Regrettably, the earth's natural processes can only absorb a fraction of these emissions. This emphasizes the

* Corresponding author: rajermani.thina@newinti.edu.my

http://dx.doi.org/10.28991/HIJ-2025-06-03-018

urgent need for immediate action to reduce GHG emissions. The heightened emission of GHGs, particularly carbon dioxide (CO_2), leads to heat retention in the atmosphere, contributing to the ongoing rise in global temperatures. The escalation of global temperatures, commonly referred to as global warming, is catalyzing climate change, reshaping our planet with a surge in severe weather events like droughts, heatwaves, heavy rains, floods, and landslides. This rapid transformation of our climate also brings about additional consequences, including rising sea levels, changes in weather patterns, ocean acidification, biodiversity loss, and public health risks [5]. Urgent and sustained actions are essential for mitigating global warming and fostering a sustainable future.

The global temperature has risen to approximately 1.2 °C above pre-industrial levels, and there is no sign of a peak in global emissions. It is crucial to limit global warming to the recognized safe threshold of 1.5 °C, as recommended by the Intergovernmental Panel for Climate Change (IPCC) in 2018 [6]. This imperative aligns with the goals of the Paris Agreement, during the UN Climate Change Conference (COP21) in Paris, which seeks to restrict the global temperature rise well below 2 °C above pre-industrial levels, with further efforts to cap the increase at 1.5 °C. Examining future projections as illustrated in Figure 1, the Stated Policies Scenario (STEPS) anticipates a temperature increase to 1.9 °C by 2050 and 2.4 °C by 2100. While slightly below the World Energy Outlook-2022 projection, these figures surpass the limits set by the Paris Agreement. In the Announced Pledges Scenario (APS), the expected temperature rise by 2100 is 1.7 °C, whereas the Net Zero Emissions by 2050 (NZE) Scenario envisions a mid-century peak followed by a decrease to approximately 1.4 °C by 2100 [7].

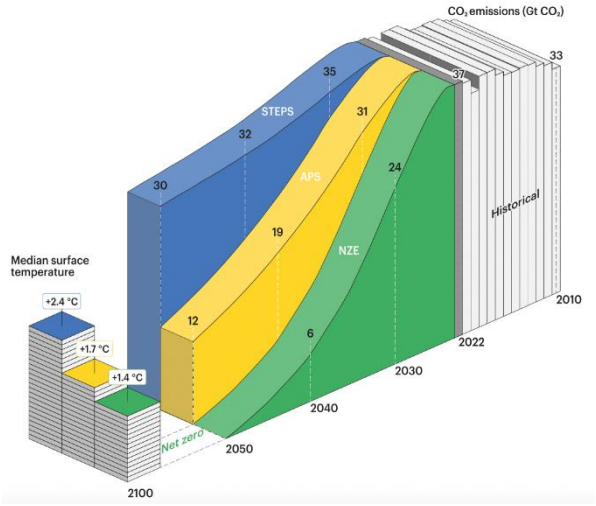

Figure 1. Future projections of the rise in temperature, 2050-2100 [7]

The escalating threat of climate change has compelled global entities to embrace sustainability as a cornerstone for a resilient future. The imperative to address carbon emissions has become particularly pronounced, prompting nations and organizations to set ambitious targets for achieving carbon neutrality. Carbon neutrality involves striking a balance between emitting carbon and absorbing it from the atmosphere in carbon sinks, a process known as carbon sequestration. Achieving NZE necessitates offsetting all GHG emissions through carbon sequestration [8]. Simply put, carbon neutrality is attained by maintaining equilibrium between CO_2 emissions and removal, resulting in NZE CO_2 emissions as illustrated in Figure 2. This balance helps prevent the increase of CO_2 in the atmosphere, mitigating its contribution to global warming, which will lead to climate change [5].

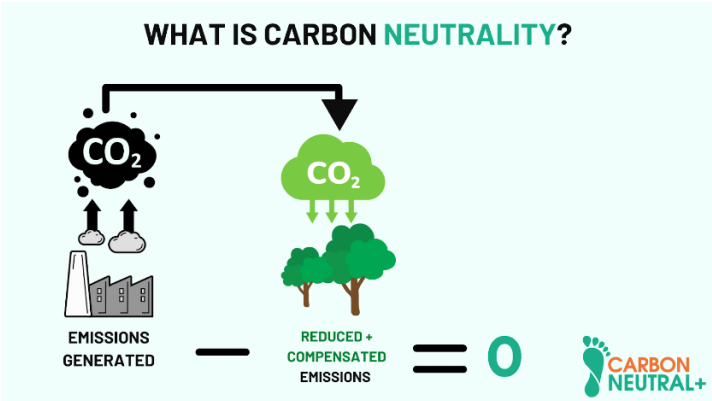

Figure 2. Overview of carbon neutrality [5]

In the transition towards a sustainable future, the responsibility for achieving carbon neutrality extends beyond nations to individual entities and corporations. Acknowledging this, the European Climate Law binds EU (European Union) nations to implement necessary domestic measures for climate neutrality by 2050, fostering fairness and solidarity. The commitment is evident, with 27 countries legally dedicated to climate neutrality by 2050, while 52 have outlined it in policy documents, 8 in the declaration stage, and 58 in discussion [4]. Malaysia is actively pursuing carbon neutrality by 2050, as indicated in its policy document [9]. Additionally, multinational corporations such as Petronas [10], Apple [11], Amazon [12], Dyson [13], Nestle [14], and Intel [15] have embarked on commendable journeys toward achieving net-zero carbon emissions, showcasing a global effort to transition to a sustainable future.

In summary, carbon neutrality has emerged as a crucial objective in the global sustainability agenda, and the duty to attain it is shared among nations, corporations, and individuals. It is a collective responsibility — 'Everyone is responsible for protecting the Earth!'. In line with national carbon neutrality objectives, this study seeks to investigate how employees within an organization can assist in reaching the organization's carbon neutrality goals, aligning with, and supporting broader national aims. Additionally, the study will explore the role of the integration of information technology (IT) solutions in facilitating and enhancing these efforts, recognizing the potential of technology in advancing sustainable practices and contributing to the achievement of carbon neutrality. These objectives align with the broader goals of United Nations SDG 13 (Climate Action) and SDG 9 (Industry, Innovation, and Infrastructure) [16].

2. Research Methodology

In the pursuit of a sustainable future, achieving carbon neutrality relies on the collaborative efforts of organizations, technology, and employees. Carbon neutrality, defined as the state where an entity's net carbon emissions are balanced by actions that remove or offset an equivalent amount of emissions, is crucial for mitigating climate change. Figure 3, a Venn diagram illustrates how these three components are integrated, Organizational Practices for Carbon Neutrality; IT Solutions for Emissions Reduction; and Employee Awareness and Engagement in Sustainability. The overlapping sections highlight the convergence of these aspects, driving sustainable actions. Organizational Practices focus on strategies to reduce carbon footprints; IT Solutions on leveraging technology for eco-friendly processes; and Employee Engagement on active participation. This visual representation emphasizes the synergistic collaboration required across organizations, technology, and individuals to achieve the goal of carbon neutrality for a more sustainable and environmentally friendly future.

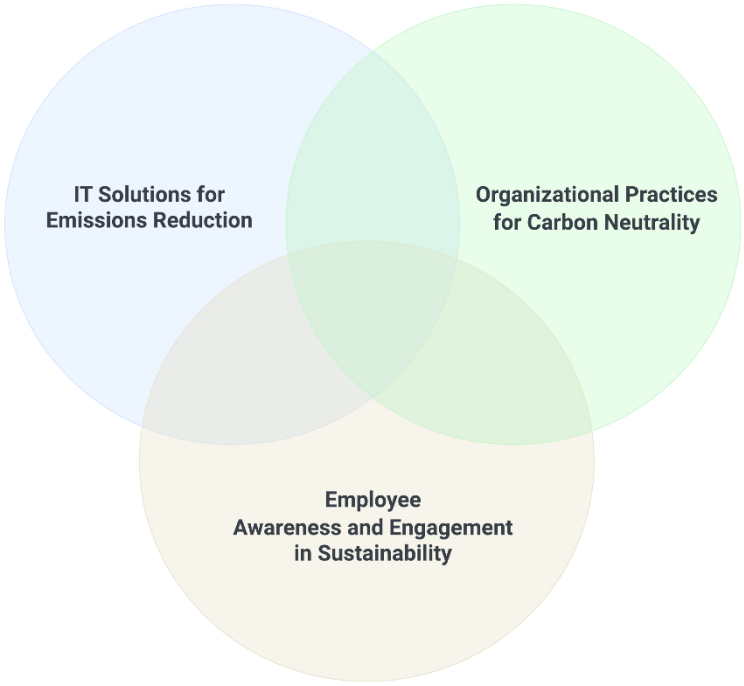

Figure 3. Interconnected elements for carbon neutrality: organizational practices, IT solutions, and employee awareness & engagement

The research design of this study embraced a multi-method approach, incorporating questionnaires and in-depth interviews (Figure 4) to thoroughly investigate the intricate interplay of employee engagement, technological integration, and organizational efforts in achieving carbon neutrality. These methods were strategically chosen to gather both quantitative and qualitative insights, providing a holistic understanding of the complex dynamics involved in sustainable practices. The survey aimed to capture numerical data, while in-depth interviews delved into participants' perceptions and experiences.

Figure 4. Research Design

The study was tailored to address three primary objectives which are 1) centered on assessing the level of awareness and consciousness among employees regarding carbon neutrality; 2) aiming to evaluate the effectiveness of companies in promoting the concept of carbon neutrality to their workforce and 3) to explore the role of IT solutions in supporting and enhancing employees' efforts towards carbon neutrality.

2.1. Quantitative Data

To gather quantitative data on sustainable practices, an online survey was conducted between November 27, 2023, and December 3, 2023. The survey comprised 12 closed-ended questions along with 15 optional test questions designed to assess participants' understanding of carbon neutrality. The survey questions are crafted to glean insights into the effectiveness of both collaborative efforts and individual contributions. The initial session concentrates on "Employee Awareness and Engagement in Sustainability," addressing research question 1: To what extent are employees aware of carbon neutrality? Subsequent sessions delve into "Organizational Practices for Carbon Neutrality," addressing research question 2: How effectively do companies communicate carbon neutrality to their workforce? and "IT Solutions for Emissions Reduction," targeting research question 3: What is the role of IT solutions in supporting employees' efforts towards carbon neutrality?

A preliminary test (pilot) was conducted before disseminating the final questionnaire. The pilot test was performed to establish reasonable levels of face validity, reliability, quality, and consistency for the final administration of the questionnaire to the survey population [17].

Participants were recruited through convenient sampling, targeting individuals from diverse industries through online distribution via social media platforms and professional networks. The sample aimed for a balanced representation of male and female participants across different age groups and years of experience in their respective industries. A minimum target of 100 respondents was set to ensure an adequate sample size for analysis [18].

Tables 1 to 3 provide an overview of the questions and objectives for each survey session, contributing valuable insights into the collective efforts and perceptions regarding sustainable practices.

Table 1. Questions and objectives of session 1 - employee awareness and engagement in sustainability

Surveys Questions	Objectives
On a scale from 1 to 10, rate your level of understanding of the concept of carbon neutrality.	To assess participants' understanding of carbon neutrality.
To what extent does your organization provide education and training on sustainability practices to employees?	To evaluate the extent of organizational education and training on sustainability practices to employees.
Does your organization foster a culture that encourages employees to propose and implement their ideas for sustainability and carbon neutrality?	To identify the existence of a culture fostering employee proposals for sustainability and carbon neutrality.
Rate the level of employee engagement in sustainability efforts within your organization on a scale from 1 to 10.	To measure the level of employee engagement in sustainability efforts.

Table 2.Questions and objectives of session 2 - organizational practices for carbon neutrality

Surveys Questions	Objectives
Does your organization have a designated sustainability or environmental department responsible for implementing carbon neutrality practices?	To verify the presence of a designated sustainability or environmental department responsible for carbon neutrality practices.
Are there established policies within your organization aimed at reducing its carbon footprint?	To examine the presence of established policies aimed at reducing the organization's carbon footprint.
How frequently does your organization communicate updates and progress on sustainability initiatives to employees?	To gauge the frequency of communication on sustainability updates and progress to employees.
Rate the effectiveness of your organization's efforts in achieving carbon neutrality on a scale from 1 to 10.	To evaluate the overall effectiveness of organizational efforts in achieving carbon neutrality.

Table 3. Questions and objectives of session 3 - IT solutions for emission reduction

Surveys Questions	Objectives
To what degree does your organization leverage IT solutions to reduce carbon emissions?	To measure the degree of leverage of IT solutions in reducing carbon emissions.
Is there ongoing investment in research and implementation of eco-friendly technologies within your organization?	To examine ongoing investment in research and implementation of eco-friendly technologies within the organization.
Rate the overall effectiveness of IT solutions in your organization's emissions reduction efforts on a scale from 1 to 10.	To rate the overall effectiveness of IT solutions in the organization's emissions reduction efforts.
From the given list, identify what are the IT solutions that have been implemented in your company.	To identify the IT solutions that have been implemented in the company from the given list.

2.2. Qualitative Data

In addition to the questionnaire, in-depth interviews were conducted with a selected group of survey participants to gain qualitative insights into their perceptions of the complex dynamics of employee engagement, technological integration, and organizational efforts in achieving carbon neutrality. The interview questions were also pilot-tested to establish reasonable levels of face validity, reliability, quality, and consistency before final administration [17].

The interviews conducted via videoconference and in-person between November 27, 2023, and December 3, 2023, in Malaysia and Singapore, involved three manufacturing professionals. These semi-structured interviews aimed to provide a nuanced understanding of participants' perspectives on the explored complexities. The interview questions designed for this study and their corresponding objectives are presented in Table 4. Each interview, lasting approximately 15 minutes, consisted of five carefully crafted questions designed to delve into the participants' experiences and insights.

All three interviewees expressed a preference not to be filmed; consequently, their responses were documented through thorough notetaking. This qualitative component aimed to provide depth and context to the quantitative findings, offering a richer understanding of the complex dynamics of employee engagement, technological integration, and organizational efforts in achieving carbon neutrality.

Table 4. Interview questions and the corresponding objectives

Interview Questions	Objectives
How familiar are you with the concept of carbon neutrality?	To measure the participant's baseline understanding of carbon neutrality.
Does your organization have a designated sustainability or environmental department responsible for implementing carbon neutrality practices?	To assess the organizational structure and responsibility allocation for carbon neutrality initiatives.
What challenges, if any, do you think organizations face in implementing and sustaining carbon neutrality initiatives?	To identify perceived challenges and barriers in the implementation and sustainability of carbon neutrality practices.
To what extent does your organization leverage IT solutions to reduce carbon emissions?	To gauge the level of integration of IT solutions in the organization's efforts to reduce carbon emissions.
How do you see emerging technologies influencing the future of sustainability efforts within organizations?	To explore the participant's perspective on the role of emerging technologies in shaping the future of sustainability initiatives.

2.3. Data Analysis

The collected data undergoes a thorough analysis to extract meaningful insights and draw conclusions. Quantitative survey responses were subjected to statistical analysis utilizing Microsoft Excel, employing descriptive statistics techniques. This approach aims to unveil patterns, trends, and correlations in the quantitative data, offering a comprehensive assessment of the awareness, engagement, and effectiveness of both organizational practices and IT solutions.

Qualitative data obtained from in-depth interviews undergoes thematic analysis to identify recurring themes, patterns, and nuanced perspectives. This qualitative analysis seeks to delve into participants' perceptions and experiences concerning the intricate dynamics of carbon neutrality initiatives. The integration of quantitative and qualitative findings,

analyzed with the support of Microsoft Excel, will facilitate a holistic interpretation of the research objectives. The synthesized results will contribute to a nuanced understanding of the intersection between employee engagement, technological integration, and organizational efforts in the journey toward carbon neutrality. Furthermore, insights from the literature review will be incorporated to contextualize and bolster the analysis, providing a robust foundation for drawing meaningful conclusions.

3. Results and Analysis

The synthesis of these diverse sources aims to provide a nuanced understanding of the intricate dynamics surrounding employee engagement, technological integration, and organizational efforts in the pursuit of carbon neutrality. The results and discussions are organized to offer a cohesive narrative, shedding light on key patterns, challenges, and opportunities identified in the study. Through a detailed exploration of each component—employee awareness, organizational practices, and IT solutions—the complex interplay shaping sustainable initiatives within organizations is unraveled. This section serves as a critical examination and interpretation of the collected data, contributing valuable insights to the broader discourse on achieving carbon neutrality.

3.1. Respondent Demographic

3.1.1. Survey base Questionnaire

A total of 108 participants responded to the survey, surpassing the target of at least 100 responses. The online survey took place from November 27, 2023, to December 3, 2023, utilizing Google Forms. The survey successfully garnered insights from a diverse demographic, with 77 (71.3%) female and 31 (28.7%) male respondents. The age distribution revealed that the majority of participants (53.7%) were in the 31-40 age range, followed by the 21-30 range (33.3%), >51 age range (7.4%), and 41-50 age range (5.6%). Geographically, the survey captured data from participants in Malaysia (74.1%), Singapore (22.2%), Vietnam (1.9%), and Taiwan and the USA (both 0.9%).

In terms of industries, manufacturing and engineering constituted the largest segment at 26.9%, followed by education (14.8%), IT and finance & banking, each comprising 12%. Healthcare and Pharmaceuticals accounted for 7.4%, while professional services and real estate & construction each represented 4.6%. Media & entertainment constituted 3.7%, and retail & e-commerce, nonprofit & social services, and automotive each contributed 1.9%. Other industries, such as hospitality & tourism, agriculture, government & public sector, transportation & logistics, fintech, piping & equipment maintenance, insurance, art industry, pest control, and product design & development, had smaller shares of 0.9% each. In terms of experience, the majority (29.6%) reported having ≥10 years of experience in their respective industries, followed by 4-6 years (25.9%), 7-9 years (22.2%), 1-3 years (16.7%), and < 1 year (5.6%)

3.1.2. Survey Based on Interview

The in-depth interview was conducted with Jacelyn Tan, the Program Director at Aratech Ptd Ltd, via a Zoom call. Aratech is a consulting company that provides services to manufacturing factories. Jacelynboasts more than 10 years of experience in her role. Additionally, an interview was held with SK Lim from Wise R Technology Sdn. Bhd. via a Zoom call, who serves as a Project Manager. SK Lim, aged 31-40, also possesses more than 10 years of professional experience. Wise R Technology is in the recycling material industry. Lastly, an interview was carried out with Horus Ong in person, the Assistant Production Manager at Momixx Malaysia Sdn Bhd. Horus, aged 21-30, has 1-3 years of work experience. Momixx Malaysia Sdn Bhd is the manufacturer of silicone rubber.

3.1.3. Overall

This comprehensive data collection provides a robust foundation for the subsequent analysis and discussion, offering valuable insights into the diverse perspectives and experiences within the surveyed demographic.

3.2. Employee Awareness Regarding Carbon

Neutrality

To fulfill research objective 1, which focuses on assessing the level of awareness and consciousness among employees regarding carbon neutrality, Session I of the survey is dedicated to 'Employee Awareness and Engagement in Sustainability'. The survey results provided valuable insights into the employees' perceptions, knowledge, and participation in sustainable practices within the organization.

3.2.1. Understanding of Carbon Neutrality

Survey Based on Questionnaire

The survey aimed to gauge participants' familiarity with the concept of carbon neutrality by asking them to rate their understanding on a scale of 1 to 10, with 1 being the least and 10 being the most. Figure 5 visually represents the

distribution of participants' responses. Notably, the majority of respondents, constituting 27.8%, placed themselves in the mid-range, selecting a score of 5. This suggests a moderate level of familiarity with the concept among participants.

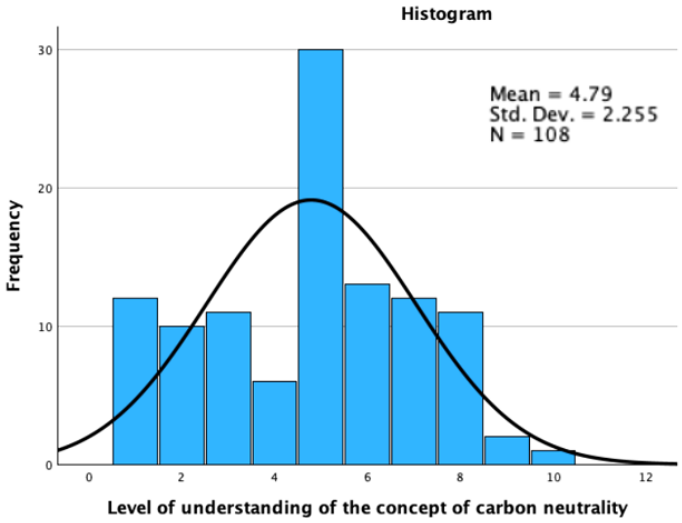

Figure 5. Survey output - understanding of carbon neutrality

It is interesting to observe that a significant percentage of participants chose scores both lower (1-4) and higher (6-10) than the mid-range. This variation in responses indicates a diverse range of understanding among the individuals surveyed. Some participants expressed a lower level of familiarity, possibly indicating a need for enhanced awareness and education on carbon neutrality. Conversely, those who rated their understanding higher might have a more advanced comprehension, potentially stemming from personal or professional experiences with sustainability initiatives.

As illustrated in Figure 5, the mean understanding score of 4.79 provides a numerical summary of the participants' collective responses. A mean below the midpoint of the scale (5) suggests that, on average, participants leaned toward a slightly lower understanding of carbon neutrality. However, the standard deviation of 2.255 indicates a considerable degree of variability in the responses. This variance highlights the dispersion of participants' opinions, reinforcing the notion that awareness levels are not uniform across the surveyed population.

3.2.2. Organizational Education and Training

Survey Based on Questionnaire

The survey included a crucial question aimed at understanding the efforts organizations invest in educating and training their employees in sustainability practices. The respondents were asked to rate the extent of such initiatives on a scale ranging from "Not at all" to "Extensively." The distribution of responses, as depicted in Figure 6 provides valuable insight into organizational practices.

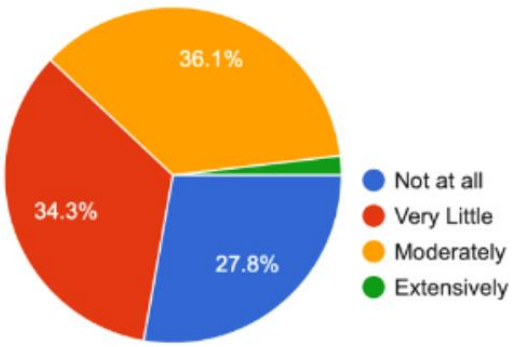

Figure 6. Survey output - organizational education and training

A noteworthy finding is that a considerable portion of respondents, specifically 36.1%, perceived their organizations to provide a moderate level of education and training on sustainability practices. This suggests that a significant number of organizations recognize the importance of imparting knowledge in this domain but may not have fully extensive programs in place.

However, it is equally significant to observe that a substantial proportion, comprising 34.3% of respondents, felt that their organizations offer very little in terms of education and training on sustainability. This indicates a potential gap in efforts to promote awareness and understanding of sustainable practices within a considerable segment of the surveyed organizations.

The data also revealed that a minority, 1.9% perceived their organizations to provide extensive education and training on sustainability. While this proportion is relatively small, it highlights the existence of organizations that are making significant strides in embedding sustainability education into their employee development initiatives.

As illustrated in Figure 7, the mean score of 2.12 provides a numerical summary, positioning the average response closer to "Very Little" on the scale. The standard deviation of 0.84 indicates a degree of variability in responses, suggesting that opinions on the extent of sustainability education are somewhat dispersed among the participants. This variability emphasizes the diverse landscape of organizational practices regarding sustainability training and underscores the need for tailored approaches to meet the specific needs of different organizations.

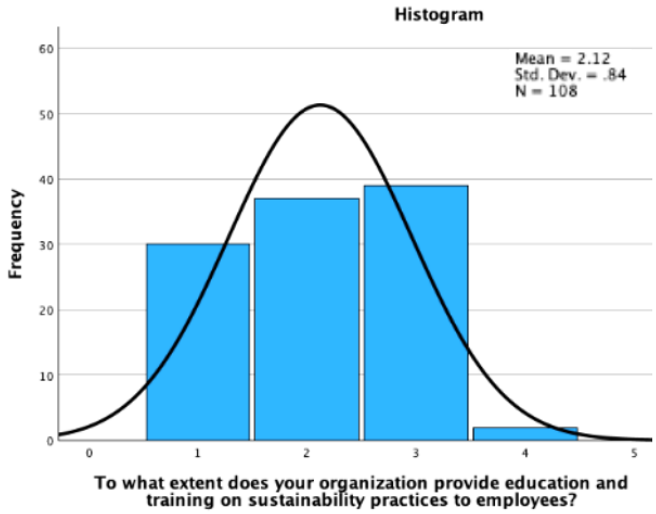

Figure 7. Histogram for the survey's output - organizational education and training

3.2.3. Employee Involvement in Proposing Ideas

Survey Based on Questionnaire

Exploring the existence of a culture encouraging employee proposals for sustainability and carbon neutrality, the survey responses revealed a spectrum of perspectives within organizations. As illustrated in Figure 8, 28.7% of respondents affirmed the presence of a culture that actively encourages employees to propose and implement their ideas for sustainability. This percentage indicates a noteworthy portion of organizations where employees feel empowered to contribute independently to sustainability initiatives.

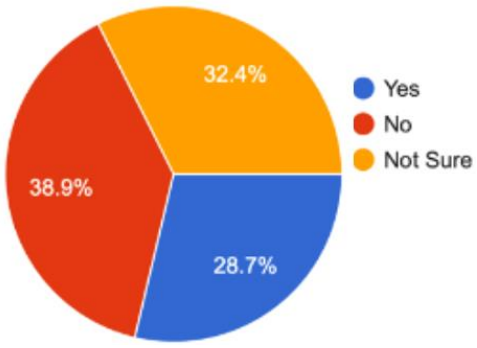

Figure 8. Survey output - employee involvement in proposing ideas

In contrast, a substantial 38.9% of respondents reported the absence of such a culture within their organizations. This finding suggests that a significant number of surveyed organizations may not have fully embraced a bottom-up approach to sustainability, wherein employees are actively encouraged to contribute their ideas and initiatives.

A notable 32.4% of respondents expressed uncertainty about the presence of a culture that fosters employee proposals for sustainability and carbon neutrality. This uncertainty underscores potential gaps in communication or awareness

within these organizations, indicating the need for clearer communication regarding the existing organizational culture related to sustainability practices.

3.2.4. Employee Engagement in Sustainability Efforts

Survey Based on Questionnaire

Participants were asked to provide a rating for the level of employee engagement in sustainability efforts within their organizations, using a scale from 1 to 10. The responses, as depicted in Figure 9, demonstrated a diverse range of perspectives. The most frequently selected rating was 5, chosen by 27.8% of respondents. This distribution across the scale suggests a mixed landscape of employee engagement levels, with a considerable percentage perceiving a moderate level of engagement.

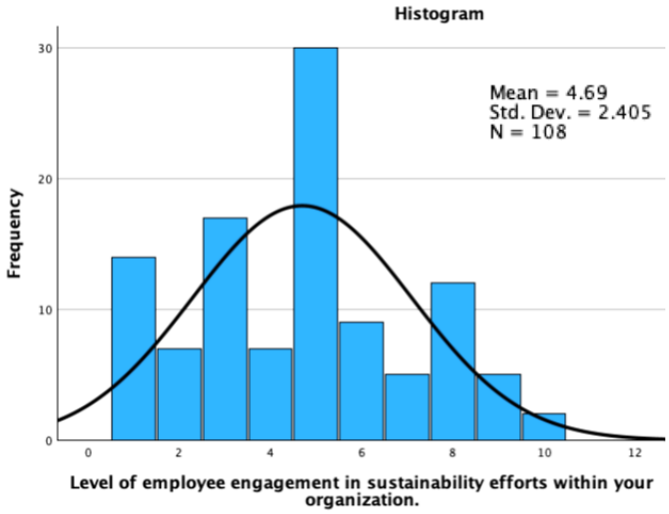

Figure 9. Survey output - employee engagement in sustainability efforts

The data from Figure 9 showcases varying degrees of employee involvement, highlighting the need for potential enhancements in initiatives aimed at increasing engagement levels. The mean score of 4.69 provides a quantitative summary, positioning the average level of perceived employee engagement closer to the mid-range of the scale.

The standard deviation of 2.405 indicates a notable degree of variability in responses, underscoring the diverse perceptions and experiences among participants regarding the current state of employee engagement in sustainability efforts. This variability suggests the presence of different levels of awareness, involvement, and perhaps varying degrees of organizational emphasis on sustainability initiatives. Addressing this variability may involve tailoring strategies to meet the specific needs and expectations of employees, contributing to a more cohesive and impactful approach to sustainability within the organization.

3.2.5. Employee Competency

Survey Based on Questionnaire

Participants were asked about their willingness to assess their competency in understanding carbon neutrality, and a substantial majority, comprising 54.6% of the 108 respondents, as illustrated in Figure 10, expressed their readiness to undertake the test. The test results, as indicated by the distribution, reflect a diverse range of competency levels among the willing participants. As illustrated in Figure 11, the mean competency score stands at 48.81%, showcasing a moderate overall competency level, while the standard deviation of 24.68% underscores the variability in individual scores. This willingness to engage in self-assessment speaks to a proactive stance among employees, reflecting a collective interest in gauging their grasp of carbon neutrality concepts.

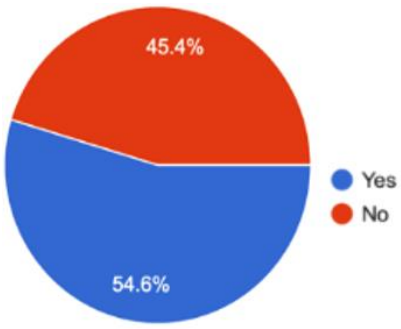

Figure 10. Survey Output - Willingness to Undertake the Test

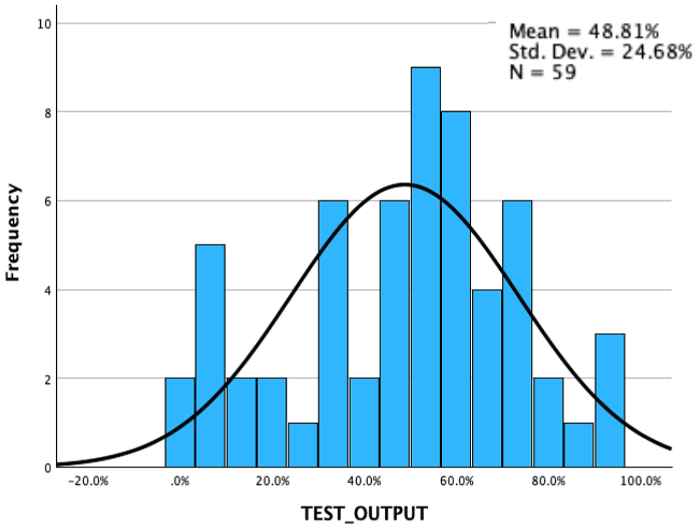

Figure 11. Test output

Survey Based on Interview

In the pursuit of enriching insights and achieving the research objective of gauging the level of awareness and consciousness among employees regarding carbon neutrality, in-depth interviews were conducted with three professionals: Jacelyn from Aratech Ptd. Ltd., SK Lim from Wise R Technology Sdn. Bhd. and Horus from Momixx Malaysia Sdn. Bhd.

The responses indicated varying degrees of familiarity with the concept of carbon neutrality. Jacelyn rated her familiarity as 7, indicating a relatively high level of awareness. She mentioned that her acquaintance with the term began approximately two years ago. In contrast, SK Lim rated himself as 6, signifying a solid awareness, while Horus rated himself as 5, indicating a moderate level of familiarity.

Both SK Lim and Horus mentioned that they recently became acquainted with the concept. A common thread in their narratives was the source of their awareness—customers. All three professionals highlighted that their introduction to the concept was prompted by customers who sent documents related to environmental, social, and governance (ESG) criteria. These documents often included compliance requirements or questionnaires related to ESG, leading them to explore and understand the concept of carbon neutrality.

This qualitative data from the interviews complements the quantitative data obtained through surveys, providing a more comprehensive understanding of how employees become aware of carbon neutrality. The combination of survey responses and insights from professionals in diverse roles contributes to a nuanced evaluation of the current landscape of awareness within organizations.

Upon thorough examination of the survey responses and insights gathered from in-depth interviews, it is evident that the study has successfully met the first research objective, which was to measure the level of awareness and consciousness among employees regarding carbon neutrality. The data obtained from both quantitative and qualitative methods has provided a comprehensive overview of the current state of employee awareness within the surveyed organizations.

The survey revealed a diverse range of awareness levels, with respondents assigning themselves ratings on a scale from 1 to 10. Additionally, in-depth interviews with professionals from different companies provided valuable qualitative insights into the sources and development of their awareness of carbon neutrality. Notably, customer interactions emerged as a common catalyst for familiarity with the concept.

3.2.6. Outcome Objective 1 - Employee Awareness Regarding Carbon Neutrality

The outcome of this research objective indicates a varied landscape of awareness among employees, with some exhibiting high levels of understanding while others are in the process of acquainting themselves with the concept. The combination of quantitative and qualitative data enriches the findings, offering a nuanced perspective on the factors influencing awareness within organizations. As a result, the study lays a foundation for targeted interventions and awareness campaigns to bridge knowledge gaps and foster a more informed workforce regarding carbon neutrality.

3.3. Organizational Practices for Carbon Neutrality

To fulfil research objective 2, which focuses on evaluating how effectively companies promote the concept of carbon neutrality to their workforce, Session II of the survey is dedicated to 'Organizational Practices for Carbon Neutrality'. The survey results provided valuable insights into the existing organizational frameworks and their impact on carbon neutrality initiatives.

3.3.1. Designated Sustainability Departments

Survey Based on Questionnaire

The survey inquired whether the participants' organizations had a designated department focused on implementing carbon neutrality practices. The responses, as depicted in Figure 12, revealed a diverse landscape within the organizations. Approximately 28.7% of the respondents affirmed the existence of a dedicated sustainability or environmental department responsible for handling carbon neutrality practices. On the contrary, 37% reported that their organizations did not have such a specialized department. Interestingly, 34.3% expressed uncertainty, indicating a lack of clarity or awareness about the presence of such departments.

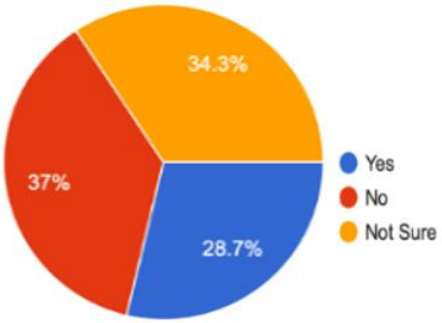

Figure 12. Survey output - designated sustainability departments

This diversity in responses suggests that different organizations have varying structures and approaches when it comes to managing sustainability initiatives. The significant number of respondents unsure about the existence of a specific department underscores the need for clearer communication and standardized practices in organizations regarding sustainability and carbon neutrality. Establishing a more consistent framework could contribute to more effective and cohesive efforts in this regard.

3.3.2. Established Policies for Carbon Footprint Reduction

Survey Based on Questionnaire

The survey aimed to uncover if organizations had policies focused on reducing their carbon footprint. As portrayed in Figure 13, the responses showcased a diverse landscape within these organizations. Approximately 19.4% of respondents confirmed the existence of established policies aimed at reducing their carbon footprint. In contrast, 30.6% stated that their organizations lacked such policies. Interestingly, another 30.6% indicated that policies were in the process of being developed.

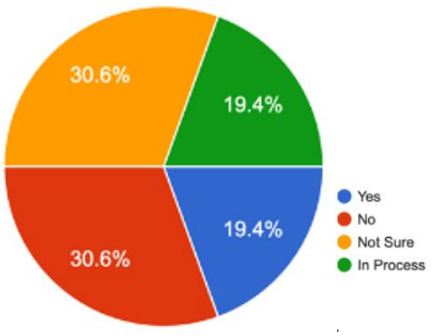

Figure 13. Survey output - established policies for carbon footprint reduction

This variation in responses highlights a significant opportunity for organizations to bolster their commitment to carbon reduction efforts through the establishment of clear and definitive policies. The equal percentage of organizations currently in the process of formulating these policies suggests a growing recognition of the importance of reducing carbon footprints. Establishing or strengthening policies in this regard could further solidify organizational dedication to sustainability practices.

3.3.3. Communication on Sustainability Initiatives

Survey Based on Questionnaire

Participants were inquired about the frequency of communication regarding sustainability updates and progress within their organizations. As depicted in Figure 14, a considerable majority (59.3%) reported rare communication practices. This suggests a notable gap in consistently updating employees about sustainability initiatives. In contrast, only 9.3% indicated regular communication on sustainability matters. This low percentage highlights an area that could be improved to foster a more transparent and consistent flow of updates to employees.

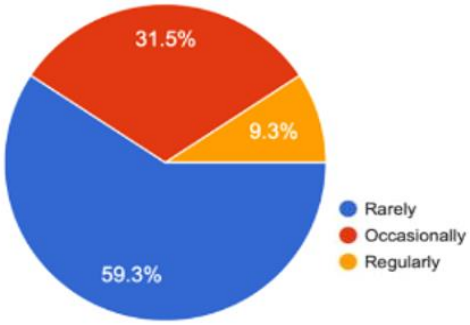

Figure 14. Survey output - communication on sustainability initiatives

The distribution displayed in Figure 15, accompanied by a mean of 1.5 and a standard deviation of 0.663, emphasizes the dominance of infrequent communication. This data underscores the potential for organizations to enhance their communication strategies, ensuring more regular and comprehensive updates on sustainability initiatives for their employees.

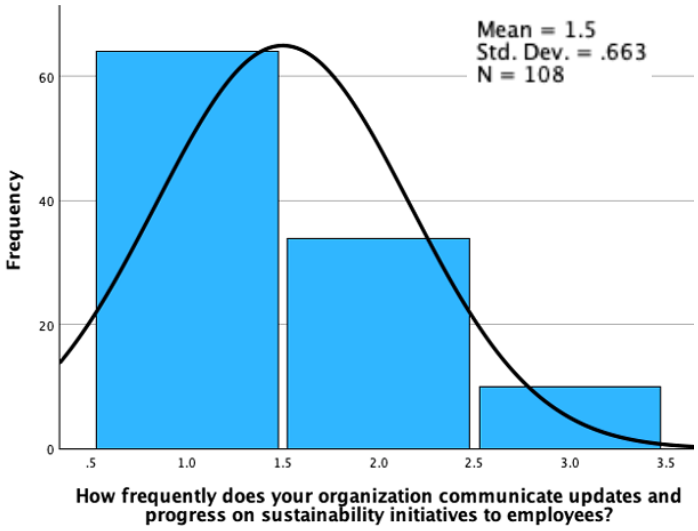

Figure 15. Histogram for the survey output - communication on sustainability initiatives

3.3.4. Effectiveness of Organizational Efforts

Survey Based on Questionnaire

The survey included a rating scale (1 to 10) to evaluate participants' perceptions of the effectiveness of their organizations' efforts in achieving carbon neutrality. the responses revealed a varied opinion, with 26.9% rating their organizations at 5 and an additional 17.6% giving a rating of 1.

This distribution suggests a diverse range of perspectives on the effectiveness of organizational efforts, indicating a need for organizations to reassess and potentially enhance their strategies to more effectively achieve carbon neutrality goals. Figure 16 displays the histogram, with a mean of 1.5 and a standard deviation of 0.663, emphasizing the variability in perceived effectiveness among the participants. This data highlights the importance of organizations refining their approaches to align with the goals of achieving carbon neutrality.

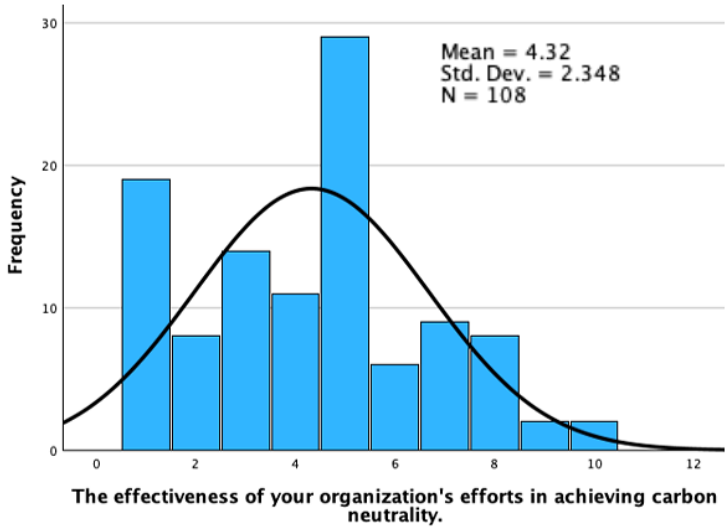

Figure 16. Histogram for the survey output - effectiveness of organizational efforts

Survey Based on Interview

To further enhance the research objectives of evaluating how effectively companies promote the concept of carbon neutrality to their workforce, insights were gathered through interviews with three professionals — SK Lim from Wise R Technology Sdn. Bhd.; Horus from Momixx Malaysia Sdn. Bhd.; and Jacelyn from Aratech Ptd. Ltd.

Regarding the presence of a designated sustainability or environmental department for implementing carbon neutrality practices, Wise R plans to establish a task force for sustainability monitoring. At Momixx, the Quality System team, responsible for social responsibility matters, oversees sustainability matters. Aratech, providing consulting and program management services, is considering sending its workers for sustainability-related certification to enhance their expertise in ESG matters.

When asked about challenges in implementing and sustaining carbon neutrality initiatives, SK Lim highlighted the competency of workers as a significant challenge. She emphasized the need for time to build a competent team, considering the complexity of carbon neutrality requirements. Budget constraints were also raised as a challenge by Horus, who discussed the potential inefficiency of task forces due to workers juggling primary job responsibilities. He pointed out the dependency on customer requirements and the need for budget allocation. Jacelyn shared challenges in her field, citing difficulties in finding training materials and filtering information due to the novelty of carbon neutrality in manufacturing. These insights provide a qualitative perspective on the challenges organizations face in promoting carbon neutrality within their workforce

3.3.5. Outcome Objective 2 - Organizational Practices for Carbon Neutrality

The amalgamation of questionnaire outcomes and interview insights offers a comprehensive understanding of the ongoing organizational endeavors aimed at achieving carbon neutrality. Notably, the survey exposes variations in organizational practices, reflecting diverse levels of commitment to sustainability. The presence of designated sustainability departments and established policies for carbon footprint reduction highlights the divergent approaches adopted by organizations. Insights from interviews underscore the critical need for clear policies and dedicated departments, indicating a pressing requirement for standardization to bolster collective efforts. The discussion on the frequency of communication regarding sustainability initiatives emerges as pivotal, with a substantial portion reporting infrequent updates. This underscores the essential role of transparent and regular communication to keep employees well-informed and engaged in organizational sustainability objectives. To usher in a sustainable and environmentally friendly future, a collaborative and integrated approach is indispensable. Organizations are pivotal in this collective effort, tasked with fostering awareness, instituting clear policies, and harnessing advanced technologies to realize the vision of carbon neutrality.

3.4. IT Solutions for Emissions Reduction

To fulfill research objective 3, which focuses on exploring the role of IT solutions in supporting and enhancing employees' efforts towards carbon neutrality, Session III of the survey is dedicated to ‘IT Solutions for Emissions Reduction'. By identifying specific areas where employees can contribute and understanding the leverage of IT solutions, the survey shed light on the technological landscape within organizations striving for emissions reduction.

3.4.1. Leverage of IT Solutions

Survey Based on Questionnaire

Participants were asked to indicate the degree to which their organizations leverage IT solutions to reduce carbon emissions. As illustrated in Figure 17, the responses revealed a varied landscape. Notably, 38% of participants reported that their organizations do not leverage IT solutions at all, while 33.3% indicated minimal use. A further 25.9% reported moderate use, and a minor 2.8% mentioned leveraging IT extensively for carbon emission reduction. The mean value of 1.94 and a standard deviation of 0.868 further emphasize the diversity in IT utilization across organizations.

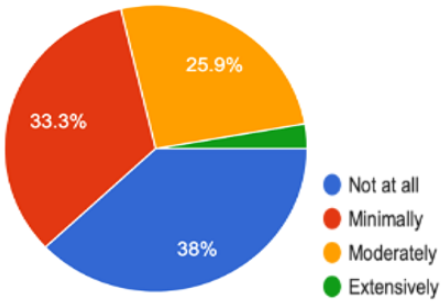

Figure 17. Survey output - leverage of IT solutions

Figure 18 visually represents the mean and standard deviation, highlighting the distribution of responses. This diversity suggests a potential area for improvement and exploration in adopting IT solutions more extensively to address carbon emissions within organizations.

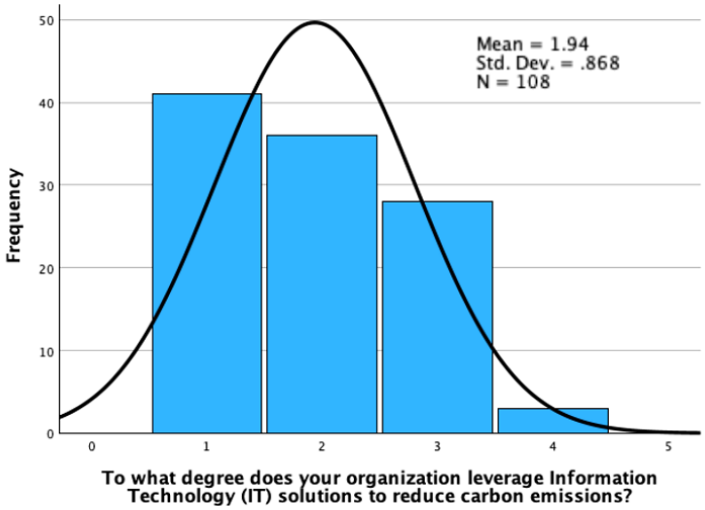

Figure 18. Histogram of the survey output - leverage of IT solutions

3.4.2. Investment in Eco-Friendly Technologies

Survey Based on Questionnaire

The survey sought to understand whether organizations were investing in research and implementing eco-friendly technologies. As illustrated in Figure 19, responses indicated a mix of orientations, with 13.9% affirming ongoing investment, 34.3% reporting no such investment, 39.8% expressing uncertainty, and 12% in the planning phase. This highlights the need for organizations to consider continuous investment in cutting-edge technologies for sustainable practices.

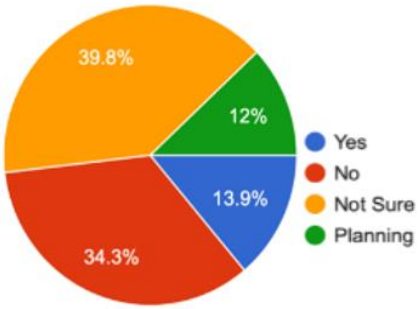

Figure 19. Survey output - investment in eco-friendly technologies

3.4.3. Overall Effectiveness of IT Solutions

Survey Based on Questionnaire

Participants were asked to rate the overall effectiveness of IT solutions in their organization's emissions reduction efforts on a scale from 1 to 10. The responses varied widely. About 16.7% rated their organization at 1, while 19.4% gave a rating of 5.

The histogram in Figure 20 visually represents the distribution, indicating diverse opinions among participants regarding the effectiveness of IT solutions. The mean value of 4.18 and the standard deviation of 2.379 highlight the range and dispersion of these ratings. This diversity suggests varied perceptions of IT solutions' effectiveness in reducing emissions within different organizational contexts.

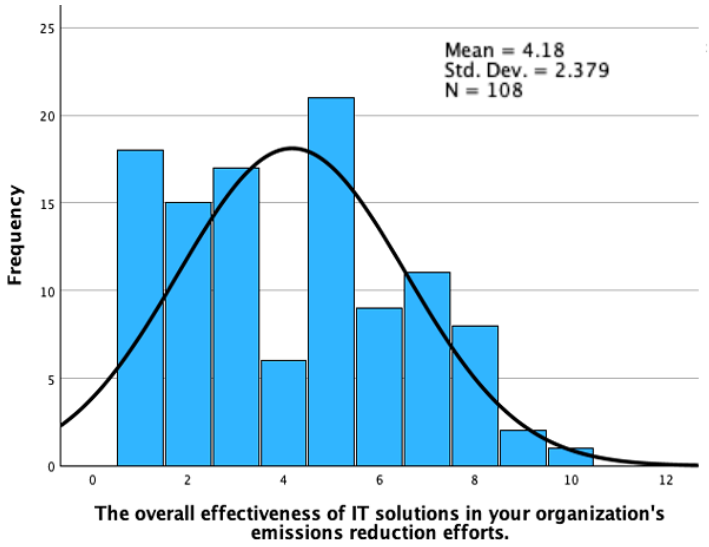

Figure 20. Histogram of the survey output - overall effectiveness of IT solutions

3.4.4. Implemented IT Solutions

Survey Based on Questionnaire

The survey included a list of IT solutions, and participants were asked to identify which ones had been implemented in their organizations. As illustrated in Figure 21 , notably, 41.7% reported none of the listed solutions, while others mentioned various technologies such as IoT for energy optimization (25.9%), cloud computing for energy efficiency (23.1%), and smart building technologies (19.4%). These responses illustrate the landscape of IT solutions adopted by organizations, emphasizing the need for tailored approaches.

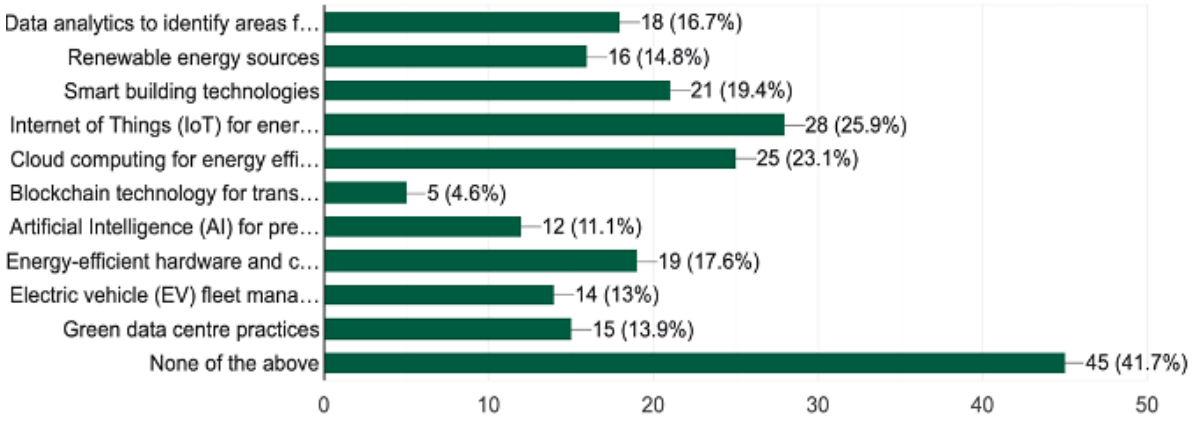

Figure 21. Survey Output - Implemented IT Solutions

Survey Based on Interview

To further enhance the research objectives of exploring the role of IT solutions in supporting and enhancing employees' efforts toward carbon neutrality, insights were gathered from interviews with professionals from Wise R,

Momixx, and Aratech. SK from Wise R mentioned that currently, her company is in the data collection phase for sustainability, and the only IT solution they've considered so far is data analytics. Horus from Momixx highlighted their engagement with a third party for computing GHG reports, emphasizing data analytics as the primary IT solution linked to sustainability. Jacelyn from Aratech mentioned the use of smart sensors in their office for electricity savings but could not identify other IT solutions for carbon emissions reduction.

Regarding the future influence of emerging technologies on sustainability efforts, all interviewees, including SK, Horus, and Jacelyn, foresaw increased automation in data collection, monitoring, and AI-driven recommendations for reducing carbon emissions. SK envisioned a future where AI systems could propose actions for carbon reduction based on automated data collected through a user-friendly webpage. Additionally, Jacelyn emphasized the potential role of blockchain technology in the trading of carbon credits, suggesting a comprehensive system for capturing, calculating, and even trading carbon emissions similar to a banking system. These insights provide a nuanced understanding of the current and future landscape of IT solutions and their impact on organizational efforts toward carbon neutrality

3.4.5. Outcome Objective 3 - IT Solutions for Emissions Reduction

The integration of survey results and interview insights provides a holistic perspective on the current state of IT solutions for carbon emissions reduction. The survey and interviews reveal a spectrum of IT solution adoption, from minimal use to extensive leveraging, signifying the diverse technological landscapes within organizations. The discussions with professionals from various industries emphasize the pivotal role of data analytics as a primary IT solution linked to sustainability, offering valuable insights into the current practices. Furthermore, the exploration of emerging technologies such as AI and blockchain for automated data monitoring and carbon credit trading showcases the potential for innovative solutions in the foundation for more effective and sophisticated approaches to address environmental challenges in the pursuit of a sustainable future.

3.5. Synergistic Collaboration across Organizations, Employee, and IT Solutions

The survey outcomes for employees reveal a diverse understanding of carbon neutrality, indicating the necessity for targeted awareness campaigns. Interviews highlight the challenges organizations face in building a competent workforce with sufficient knowledge, emphasizing the importance of comprehensive training programs to bridge the knowledge gap.

For organizations, survey results expose disparities in sustainability practices, with varying commitment levels. Differences exist in designated sustainability departments and the presence of policies for carbon footprint reduction. Interviews underscore the need for clear policies and dedicated departments, suggesting standardization to enhance collective efforts. The frequency of communication on sustainability initiatives emerges as crucial, underscoring the necessity for transparent and regular communication. Regarding IT solutions, the survey and interviews show a spectrum of adoption, from minimal use to extensive leveraging. Discussions with professionals stress the role of data analytics as a primary IT solution linked to sustainability. The potential integration of emerging technologies like AI and blockchain for automated data monitoring and carbon credit trading signals a promising direction for future sustainability efforts.

In summary, achieving carbon neutrality requires synergistic collaboration across organizations, technology, and individuals. Well-informed and engaged employees, supported by clear organizational policies, form the foundation. Technology, especially IT solutions, plays a pivotal role, with data analytics emerging as a key enabler. The insights from emerging technologies suggest transformative potential for automation and improved monitoring. The ultimate goal is to minimize environmental impact and work towards a sustainable future. The findings underscore the need for a collective and concerted effort, standardizing practices, enhancing communication, and embracing innovative technologies.

In ending, this discussion emphasizes the correlation of organizational, technological, and individual elements in the journey toward carbon neutrality. A collaborative and integrated approach is imperative, where organizations foster awareness, implement clear policies, and leverage advanced technologies. Figure 22 provides an overview of the interconnection between organization, employee, and IT solutions. The organization, in deciding climate change approaches, evaluates strategies and aligns with sustainability practices, translating decisions into tangible actions through policies. Effective communication ensures employees understand their role, while organizational investment in IT solutions supports sustainability goals. Employees, through training, learn to utilize IT tools for sustainability, contributing to a comprehensive and effective approach.

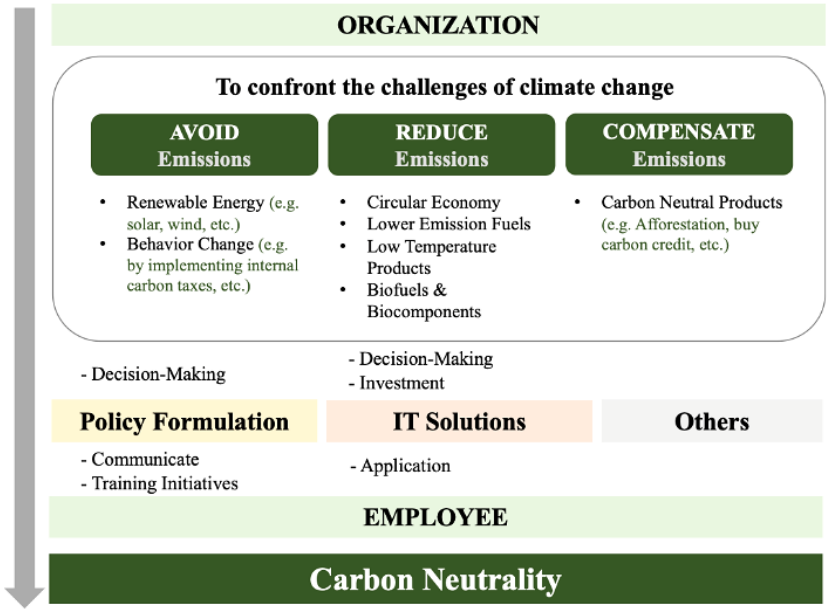

Figure 22. Overview of the interconnection between organization, employee, and IT solutions

4. Conclusion

Overall, this research has provided a holistic understanding of organizational efforts toward carbon neutrality by examining employee awareness, organizational practices, and the role of IT solutions. The study reveals the need for targeted awareness campaigns among employees to bridge knowledge gaps and establish a collective understanding of carbon neutrality. Disparities in organizational sustainability practices underline the importance of standardized policies and dedicated departments. Effective communication, including regular updates and comprehensive training programs, is crucial for keeping employees informed and engaged. The survey and interview insights highlight the varying degrees of IT solution adoption, emphasizing the significance of data analytics and the potential integration of emerging technologies like AI and blockchain. These findings underscore the interconnectedness of organizational, technological, and individual elements in the pursuit of carbon neutrality.

Moving forward, organizations are encouraged to standardize sustainability practices by establishing dedicated departments and clear policies for carbon footprint reduction. Improving communication on sustainability initiatives, including regular updates and comprehensive training, can enhance employee engagement. Optimization of IT solutions, particularly focusing on data analytics and exploring emerging technologies, is crucial. Continued research and adaptation to dynamic sustainability practices and technological advancements are recommended to ensure ongoing relevance. Collaboration across sectors, including government bodies, NGOs, and industry partners, is essential to foster a collective effort toward carbon neutrality. By standardizing practices, enhancing communication, optimizing IT solutions, staying informed, and fostering collaboration, organizations can significantly contribute to a sustainable and environmentally friendly future.

5. Declarations

5.1. Author Contributions

Conceptualization, C.R.Q., R.T., R.P.T.A., T.A.R., S.D.R., and L.K.; methodology, C.R.Q., R.T., and R.P.T.A.; software, T.A.R., S.D.R., and L.K.; validation, C.R.Q. and R.T.; formal analysis, R.P.T.A., T.A.R., S.D.R., and L.K.; writing—original draft preparation, C.R.Q., R.T., R.P.T.A., T.A.R., S.D.R., and L.K.; writing—review and editing, C.R.Q., R.T., R.P.T.A., T.A.R., S.D.R., and L.K. All authors have read and agreed to the published version of the manuscript.

5.2. Data Availability Statement

The data presented in this study are available on request from the corresponding author.

5.3. Funding

The authors received no financial support for the research, authorship, and/or publication of this article.

5.4. Institutional Review Board Statement

Not applicable.

5.5. Informed Consent Statement

Informed consent was obtained from all subjects involved in the study.

5.6. Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

6. References

[1] Bonneuil, C., Choquet, P. L., & Franta, B. (2021). Early warnings and emerging accountability: Total's responses to global warming, 1971–2021. Global Environmental Change, 71. doi:10.1016/j.gloenvcha.2021.102386.

[2] Iacobuță, G. I., Brandi, C., Dzebo, A., & Elizalde Duron, S. D. (2022). Aligning climate and sustainable development finance through an SDG lens. The role of development assistance in implementing the Paris Agreement. Global Environmental Change, 74. doi:10.1016/j.gloenvcha.2022.102509.

[3] Ahmad, T., Kumar, N., Kumar, A., Mubashir, M., Bokhari, A., Paswan, B. K., & Qiblawey, H. (2024). Unveiling the potential of membrane in climate change mitigation and environmental resilience in ecosystem. Environmental Research, 245, 117960. doi:10.1016/j.envres.2023.117960.

[4] IEA. (2022). Global CO_2 emissions rebounded to their highest level in history in 2021. International Energy Agency (IEA), Paris, France.

[5] Chen, J. M. (2021). Carbon neutrality: Toward a sustainable future. The Innovation, 2(3), 100127. doi:10.1016/j.xinn.2021.100127.

[6] IPCC. (2022). Climate Change: A Threat to Human Wellbeing and Health of the Planet. Taking Action Now Can Secure Our Future. The Intergovernmental Panel on Climate Change (IPCC), Geneva, Switzerland.

[7] IEA. (2018) CO_2 Emissions from Fuel Combustion 2018-Highlights. International Energy Association (IEA), Paris, France.

[8] European Parliament. (2022). What Is Carbon Neutrality and How Can It Be Achieved by 2050. European Parliament, Strasbourg, France.

[9] Chen, L., Msigwa, G., Yang, M., Osman, A. I., Fawzy, S., Rooney, D. W., & Yap, P.-S. (2022). Strategies to achieve a carbon neutral society: a review. Environmental Chemistry Letters, 20(4), 2277–2310. doi:10.1007/s10311-022-01435-8.

[10] Rahman, M. N., & Wahid, M. A. (2021). Renewable-based zero-carbon fuels for the use of power generation: A case study in Malaysia supported by updated developments worldwide. Energy Reports, 7, 1986–2020. doi:10.1016/j.egyr.2021.04.005.

[11] Webb, D. (2023). Sustainability Leadership: Mapping The Path to Net Zero and Beyond with Apple, Google, And Microsoft. Master Thesis, Johns Hopkins University, Baltimore, Maryland.

[12] Palmer, A. (2023). Amazon sees decline in carbon emissions for the first time. CNB, Los Angeles, United States. Available online: https://www.cnbc.com/2023/07/18/amazon-sees-decline-in-carbon-emissions-for-the-first-time.html (accessed on June 2025).

[13] Dyson, J. (2023). Sustainability at Dyson. Dyson, Singapore. Available online: https://www.dyson.com/sustainability (accessed on August 2025).

[14] Nestle. (2023). Nestle Net Zero Roadmap. Nestle, Vevey, Switzerland. Available online: https://www.nestle.com/sites/default/files/2020-12/nestle-net-zero-roadmap-en.pdf (accessed on August 2025).

[15] Intel. (2022). Intel Commits to Net-Zero Greenhouse Gas Emissions in its Global Operations by 2040. Intel, Santa Clara, United States. Available online: https://www.intel.com/content/www/us/en/newsroom/news/net-zero-greenhouse-gas-emissions-operations.html (accessed on August 2025).

[16] Sinha, A., Sengupta, T., & Alvarado, R. (2020). Interplay between technological innovation and environmental quality: Formulating the SDG policies for next 11 economies. Journal of Cleaner Production, 242, 118549. doi:10.1016/j.jclepro.2019.118549.

[17] Ken Lun, C. C., Rong, T. H., Seng, L. K., Cheah Ni, C. C., Thinakaran, R., Tin, T. T., & Batumalay, M. (2022). a Case Study on the Impact of Video Games Towards Malaysian Youth. Journal of Theoretical and Applied Information Technology, 100(19), 5840–5853.

[18] Roscoe, J. T. (1969). Fundamental research statistics for the behavioral sciences. Holt Rinehart and Winston, New York, United States.