Journal of Information Systems Engineering and Management
2024, 9(1), 21636
e-ISSN: 2468-4376
https://www.jisem-journal.com/
Research Article

Assessing the Mediating Role of E-Techniques in the Relationship Between Information Systems and Carbon Reduction Strategies During the Construction Phase of Chinese Construction Projects

Junjie Li [1], Ernawati Binti Mustafa Kamal [2*], Khoo Terh Jing [3]

[1] Ph.D candidate, School of Housing, Building & Planning, Universiti Sains Malaysia, Penang, Malaysia
[2] Doctor, Main supervisor, School of Housing, Building & Planning, Universiti Sains Malaysia, Penang, Malaysia
[3] Doctor, Deputy supervisor, School of Housing, Building & Planning, Universiti Sains Malaysia, Penang, Malaysia
* **Corresponding Author:** ernamustafa@usm.my

Citation: Li, J., Kamal, E. B. M., & Jing, K. T. (2024). Assessing the Mediating Role of E-Techniques in the Relationship Between Information Systems and Carbon Reduction Strategies During the Construction Phase of Chinese Construction Projects. *Journal of Information Systems Engineering and Management*, 9(1), 21636. https://doi.org/10.55267/iadt.07.14183

ARTICLE INFO

Received: 13 Nov 2023
Accepted: 17 Jan 2024

ABSTRACT

In recent years, information systems have become increasingly popular for supporting sustainable operations, especially in carbon reduction efforts. Due to the need to minimize carbon emissions and adopt green practices, organizations are increasingly using information systems to achieve these aims. By using e-techniques as a mediator and taking into account the moderating effects of project orientation and project complexity, this quantitative study seeks to clarify the connection between information systems and carbon reduction approaches. e-techniques connect information systems to carbon reduction efforts. The results imply that project emphasis and complexity affect information systems and carbon reduction approaches. To test these hypotheses, 470 Chinese construction companies that use information systems to reduce carbon emissions were studied. Structural equation modeling determined variable relationships and mediating and moderating factors. This quantitative investigation shows that information systems help companies minimize carbon emissions. This suggests that information systems are highly effective for increasing sustainability in this context. It also emerged that electronic procedures mediate the interaction between information systems and carbon-reduction activities. Project direction and complexity operate as a moderating element, affecting the relationship between information systems and carbon reduction initiatives. The study explores how project direction and complexity impact carbon emission reduction information system efficacy.

Keywords: Information Systems, Carbon Reduction Strategies, E-Techniques, Project Orientation, Project Complexity.

INTRODUCTION

Information systems (IS) enable businesses to make decisions, coordinate activities, and manage themselves by collecting, processing, storing, and distributing data (Munz, Gindele, & Doluschitz, 2020). IS first enhances efficiency and production by reducing repetitive tasks, errors, and procedures. This saves businesses time and resources for other critical activities (Tso, Au, & Hsiao, 2022). Information systems promote decision-making with fast, accurate, and relevant data (Critten, Messer, & Sheehy, 2019). Information systems accelerate the introduction of new services, products, and processes, encouraging innovation and adaptability. This helps companies compete and adjust quickly to market developments. IT makes organizations customize their offers to customers, improving customer experiences. This boosts consumer loyalty and satisfaction (McCarthy, Maor, McConney, & Cavanaugh, 2023). IS helps businesses manage rule compliance and reduce risks. This is done by exposing performance metrics and risks. IS promotes worker cooperation and information exchange, which enhances creativity and problem-solving (Critten et al., 2019). Promoting information interchange and cooperation across departments and teams may enhance results and performance by tapping employee intelligence. This study shows the capacity influence of statistical structures and e-techniques on carbon reduction methods and the importance of project orientation and complexity in achieving these aims. This study has important implications for sustainable business operations and provides valuable insights for scholars and practitioners (Kotsyuba, Shikov, & Mihailov, 2021).

Zhao, Garrido-Baserba, Reifsnyder, Xu, and Rosso (2019) suggest limiting carbon emissions to halt climate change is crucial. This shields humans and the planet from greenhouse gas harm. Carbon reduction helps landscapes, natural resources, and social fairness. Carbon reduction measures boost economic development, low-carbon markets, and innovative ideas (Junxin Wang, Jiang, X. Dong, & K. Dong, 2021). Because they collect, analyze, and communicate precise energy and carbon pollution data, information systems help cut CO_2 levels, according to J. Xu, Shi, Xie, and Zhao (2019). Businesses may enhance their procedures and reduce carbon emissions using this knowledge. The shifting environment of technological progress encourages more individuals to cut carbon emissions, making the process more efficient and effective. IT is spurring transformation, helping businesses save energy and money and reduce carbon emissions (Liao, Liang, & He, 2022). IT's collaborative nature makes carbon reduction easier for everyone. Data-driven carbon price approaches, as described by F. Dong et al. (2022), might transform resource consumption and decision-making. Organizations may enhance resource utilization and environmental care by using statistics like electricity use and carbon emissions.

The impact of extended heading and complexity on IS-based carbon lessening is ineffectively investigated. This setting has small investigations on e-techniques as go-between. IS diminishes emanations, but few inquiries have inspected the complex work of sent e-technologies as arbiters (H. Wang, Zhan, Ng, & Cheng, 2020). Investigate is missing on how extended complexity and course influence IS-carbon diminishment connections. Finding experiences that help professionals optimize IS utilization for carbon lessening is vital. A more profound ponder is required to determine how carbon decrease, data frameworks, electronic strategies, venture administration, and venture complexity are associated.

Ahmed, Naeem, Ejaz, Iqbal, and Anpalagan (2018) examine how information systems reduce carbon emissions. They focus on how project direction impacts information systems, e-techniques, and carbon diminishment. Our research looks at how extended complexity influences IT, e-technology utilisation, extended direction, and carbon decrease. This activity points to a forward insightful understanding of how enterprises deliberately utilize electronic innovation and data frameworks to play down carbon outflows for supportability. Syreyshchikova et al. (2021) clarify the perplexing relationship between extended course and complexity, which influences these arrangements. This investigation makes a difference in firms selecting carbon-reducing IT and e-tech arrangements. The consideration will look at data frameworks and carbon decrease. This includes dissecting the complex organization of electronic strategies that connect data frameworks and carbon lessening and how the project's course influences data innovation, e-technology, and carbon lessening. The examination looks at how venture complexity influences data frameworks, e-technologies, carbon diminishment, and venture technique. This research enhances understanding of how statistical structures and electrical technologies affect carbon reduction and emphasizes the need to tailor solutions to individual projects' unique characteristics and complexities to achieve overall goals. Researchers and practitioners developing sustainable business strategies can learn from this study.

LITERATURE REVIEW

Information Systems

Modern firms use information systems to make smart decisions and gain a competitive edge. The literature review covers IS types, components, and business activities. System types include transaction processing systems (TPS), management information systems (MIS), decision support systems (DSS), and executive information systems (EIS) (J. Wang, S. Wang, Zhang, & Deng, 2023). The simplest kind of IS, known as TPS, is in charge of gathering and processing data from regular transactions. MIS offers data to aid middle-level managers in making decisions. DSS is made to offer assistance with non-routine decision-making tasks. High-level executives have a complete picture of the organization's performance thanks to EIS. The significance of IS's elements, such as its technology, software, data, people, and procedures (Avotra & Nawaz, 2023; Nawaz, Chen, & Su, 2023b). Networks, servers, and computers are examples of hardware components. Operating systems, application software, and databases are examples of software components. The data that IS collects, manipulates, and stores are considered data components. People components include end users, system administrators, and IT staff, as well as people who use and maintain the system (Jelenic, 2011). Procedures are the instructions and standards followed when operating and maintaining a system. IS can boost innovation, promote strategic planning, improve operational effectiveness, and improve decision-making. By allowing firms to adapt to shifting market conditions and consumer needs, IS also helps them gain a competitive edge (Akay, Lee, & Kim, 2023).

Carbon Reduction Strategies

Strategies for reducing carbon dioxide emissions and reducing the effects of climate change are referred to as carbon reduction strategies. The efficiency of carbon reduction measures is the main emphasis of this review's current literature analysis. The usage of renewable electricity sources is one of the maximum appreciably researched carbon reduction answers (Gyamfi, Agozie, & Bekun, 2022). Increased utilization of renewable strength resources, like wind, solar, and hydropower, has been determined in numerous research to dramatically lower carbon emissions. According to Liao et al. (2022), switching to simplest renewable power assets might also reduce global carbon emissions. Energy efficiency is every other technique for lowering carbon emissions. Numerous studies have established that slicing carbon emissions can be carried out by increasing energy performance in homes, transportation, and enterprises. For instance, Lin, O'Shea, Deng, Wu, and Murphy (2021) indicated that increasing construction power performance also reduces international carbon. Another method for lowering carbon emissions that has attracted numerous interest recently is Carbon Capture and Storage (CCS) (Charfeddine & Kahia, 2021). CCS entails sequestering and burying carbon dioxide emissions from factories, electricity stations, and different business sources. CCS has the capacity to notably decrease carbon emissions, in line with numerous studies. In addition to these tactics, there are a number of laws and rules designed to decrease carbon emissions. Many nations have put in place carbon taxes, and renewable electricity necessities to encourage the use of low-carbon technologies (Nawaz, Su, & Nasir, 2021; Nawaz, Chen, & Su, 2023a).

E-Techniques in Construction Projects

Electronic techniques, often known as e-strategies, have become an increasingly more normal manner to enhance communication and trade in numerous industries. The way that people and groups feature has changed dramatically due to the employment of digital gear in business, education, healthcare, and other sectors (Fahim et al., 2022). Examining the present degree of observation on e-techniques and their results in diverse industries is the intention of this literature overview. E-strategies have been applied within the company globally to enhance communication, streamline tactics, and increase output. Employees can also now have interaction and paintings together irrespective of where they are physically located thanks to digital communication technology like electronic mail, on-the-spot messaging, and video conferencing. According to studies, e-strategies improve workplace performance, decision-making, and job satisfaction (Butz & Hancock, 2019). Education and procedures have improved using e-strategies. Gamification, multimedia, and electronic simulations improve learning. Heaney, Hunter, Clulow, Bowles, and Vardoulakis (2021) claim that e-techniques can boost student engagement, retention, and learning. Healthcare operations and patient care have been improved by electronic technology. Medical practitioners can quickly and easily access patient data using electronic health records (EHRs), improving patient outcomes (Wong, Cunha-Cruz, Heaton, Taylor, & Truelove, 2022). Electronic technology in telemedicine and remote consultations has improved healthcare access for rural and underserved areas. Zhu et al. (2021) found that e-technologies can improve patient satisfaction, healthcare costs, and outcomes.

Project Orientation

Project orientation is a planned strategy for directing and monitoring work that focuses on meeting goals to a deadline. This idea has grown in favor as firms seek to increase efficiency and efficacy. This literature review will examine the most important project direction concepts and studies. A project-oriented strategy helps focus efforts and devote resources to specified goals. This boosts creativity, decision-making, and productivity. Project orientation improves public and private sector performance (Nawaz, Waqar, Shah, Sajid, & Khalid, 2019; Nawaz et al., 2021). Project orientation might be difficult. Working with larger firms or complicated projects might make it challenging to achieve such high collaboration and coordination. Project "tunnel vision," when specialized aims are prioritized over company goals, is another concern. Management technique selection is critical for project orientation success. Hina, Hassan, Parveen, and Arooj (2021) found that project-focused cultures benefit from transformational leadership, which emphasizes inspiration, empowerment, and vision. Project managers need good interpersonal and communication skills and knowledge of project management processes and technology (Syreyshchikova et al., 2021). Agile, waterfall, and hybrid project management models are also important.

Organization, implementation, and oversight frameworks allow projects to be completed quickly and cost-effectively (Bohari, Skitmore, Xia, Teo, & Khalil, 2020). Remember that opportunity techniques may assist particular project categories, and be flexible when adapting approaches to unique organizational situations (Zaman, Nadeem, & Nawaz, 2020). Remember that project orientation does not guarantee a universal solution. This strategy's applicability depends on resource availability, project size and complexity, and task type. Thus, before implementing a task-oriented approach, firms should assess their goals and demands (Zhou & Rose, 2021).

Information Systems and Carbon Reduction Strategies

Information systems have revolutionized business operations. Due to the rising importance of environmental sustainability, many organizations prioritize carbon emission reduction strategies. These initiatives optimize processes and eliminate inefficiencies to lower the company's carbon impact. Information technology can boost carbon-reduction efforts. The source is from Cao and AlKubaisy (2022). Several studies suggest IT may cut firm carbon emissions. Information systems may help firms measure carbon emissions and enhance the environment, according to Ahmed et al. (2018). Information technology helps organizations measure and quantify carbon emissions and energy usage (Lee, T. S. Kim, Chang, & J. Kim, 2022). Real-time energy consumption data from information systems can help firms improve. Information systems can also reduce carbon emissions. Information systems can help companies reduce carbon emissions. It has been studied that information technology can assist build carbon trading systems to incentivize enterprises to minimize carbon emissions. Fu and Niu (2023) found that information systems streamline processes and discover energy-saving opportunities, helping enterprises save energy. The use of information technology to reduce carbon emissions has hurdles. Information systems may be expensive to design and maintain, and if they don't collect all important data, they may inhibit carbon reduction efforts.

H1: Information systems have a significant and positive impact on carbon reduction strategies.

Information Systems and E-Techniques

The use of statistical tools has expedited electronic techniques. Modern commercial operations including e-commerce, e-advertising and marketing, e-learning, and e-government use digital platforms. By adding information systems to digital blueprints, companies have increased productivity, cut costs, and streamlined processes. Makini, Oguntola, and Roy (2020) state that the integration of information systems and electronic commerce (e-trade) has changed how firms deal. E-commerce is the online purchase and sale of products and services. Information systems in e-commerce allow businesses to target worldwide customers, reduce transaction costs, and boost operational efficiency. The author claims that information systems in electronic commerce have created new business models like digital platforms and online marketplaces. Information systems in electronic marketing allow organizations to tailor their marketing tactics to specific target groups. Information systems in e-advertising and marketing have purportedly spurred the growth of mobile and social media marketing (Himeur et al., 2022). IS has enabled the collection, analysis, and use of consumer data for targeted advertising and marketing activities, according to the authors. Integration of information systems and e-learning has created virtual learning environments and digital publishing. E-learning with information systems helps educational institutions to offer flexible learning options, save money, and reach a worldwide audience, (Albahri et al. 2023). Customized learning environments allow students to study at their own speed and from anywhere with e-mastering software (Cherukunnath & Singh, 2022). Information technology in e-government allows governments to perform public services more efficiently and effectively. It has been found that information systems in electronic governance increase transparency, cost, and service delivery. Heaney et al. (2021) state that information systems in e-government have enabled electronic access to public services, removing the requirement for in-person government interactions.

H2: Information systems have a significant and positive impact on e-techniques.

E-Techniques and Carbon Reduction Strategies

Because they can increase energy efficiency, optimize energy consumption, and allow the integration of renewable energy sources into the grid, e-techniques are seen as a possible option to minimize carbon emissions. Enhancing power performance is one of e-strategies' maximum important outcomes in carbon reduction strategies (Li, Song, Cai, Bian, & Mohammed, 2022). The capability of e-techniques to optimize energy intake has a tremendous effect on carbon reduction techniques. Consumers may additionally understand their power use behavior and pinpoint areas for improvement with the aid of clever meters and actual-time energy monitoring devices. The grid may now comprise renewable power resources thanks to e-strategies (Lee et al., 2022). The fluctuation and erratic nature of renewable electricity sources like solar and wind energy may be managed with the use of virtual technologies like micro grids, power garage structures, and demand response systems. The effectiveness of e-strategies in carbon reduction measures is influenced through a range of things (Ali et al., 2021;

Huo et al., 2021). For the deployment of e-techniques, it is first important to have access to virtual infrastructure such as high-speed net connectivity, data facilities, and cloud computing services. Second, that allows you to make it viable for lots of e-techniques to be blanketed right into a single gadget, open requirements and protocols for information transmission and interoperability should be evolved. Third, the powerful utility of e-techniques depends on the involvement and engagement of stakeholders which include customers, utilities, regulators, and legislators (Li et al., 2022).

H3: E-techniques has a significant and positive impact on Carbon Reduction Strategies

Mediating Role of E-Techniques Between Information Systems and Carbon Reduction Strategies

E-techniques have been identified as a means to reduce carbon emissions in the use of IS. Cloud computing, for example, can reduce the need for physical servers and associated energy consumption (Fahim et al., 2022). Similarly, virtualization can enable the sharing of physical resources, reducing the number of physical servers required and associated energy consumption. E-techniques have been found to mediate the relationship between IS and carbon reduction strategies. Li et al. (2022) stated that the use of cloud computing had a superb impact on carbon reduction strategies, with cloud computing mediating the relationship between IS and carbon reduction. Similarly, Liang, Dong, Wang, and Zhang (2020) found that using virtualization had a high-quality impact on carbon reduction techniques, with virtualization mediating the connection between IS and carbon reduction.

H4: E-techniques significantly mediate the relationship between information systems and carbon reduction strategies.

Moderating Role of Project Orientation Between Information Systems and Carbon Reduction Strategies

Yeatman and White (2021) say enterprise-level carbon reduction requires information systems. These projects develop energy-efficient technologies, renewable energy, and logistics and transportation networks. Data-driven insights from IT assist decision-makers manage these projects. Important environmental considerations like project direction might alter these techniques. Project orientation—how much an organization prioritizes project-based activities (Syreyshchikova et al., 2021)—affects carbon reduction efficiency. Strong project orientation—organizations that fully commit to goals and deadlines—often reduce carbon emissions. Research shows that project-oriented companies integrate IT better into their business goals, boosting their chances of success (Tsay, Yeh, & Jheng, 2023). Empirical research shows that project-oriented techniques increase information system-environmental performance relationships. Project-oriented firms may smoothly integrate information systems, explaining the favorable association. Integrating technology-driven activities and corporate goals creates a unified carbon reduction approach. More research is needed to confirm and explain these findings. Analyzing organizational environments and procedures may help us understand the complex interaction between environmental performance, project direction, and information systems.

H5: Project orientation significantly moderates the relationship between information systems and carbon reduction strategies.

Moderating Role of Project Complexity Between Information Systems and Carbon Reduction Strategies

It has been demonstrated that the use of information systems can play a key part in easing the process of putting carbon reduction initiatives into action. The implementation of IS in supply chain operations can enhance energy performance and lead to a reduction in carbon emissions (Dong, 2016). IS may be used to display and track carbon emissions in businesses, mainly to step forward in choice-making and extra successful methods for decreasing carbon emissions. According to Princes and Said (2022), the time period refers back to the diploma to which a mission is defined by means of factors together with unpredictability, dependency, and specialty. It is viable for the complexity of a project to have an effect on the implementation of IS and measures to lessen carbon emissions. According to the findings of a look at achieved by means (Bhamidipati & Hansen, 2021), the complexity of renewable energy initiatives could make it tough to execute IS, which in flip reduces the performance of carbon reduction measures. **Figure 1** has been developed based on the literature discussed above and hypothesis development.

H6: Project complexity significantly moderates the relationship between information systems and carbon reduction strategies.

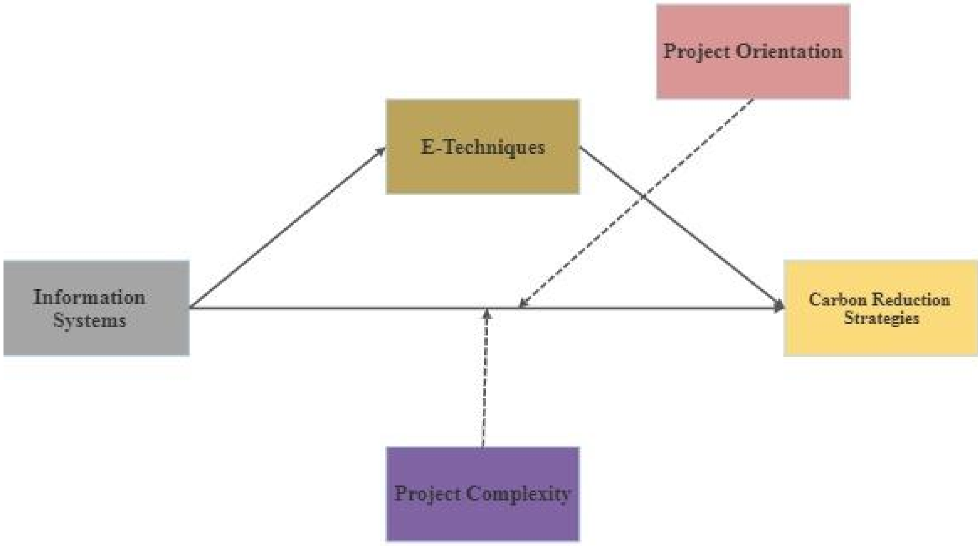

Figure 1. Conceptual Framework

METHODOLOGY

This study aimed to investigate the impact of information systems on carbon reduction strategies, with e-techniques as a mediating variable and project orientation and project complexity as moderating variables. This chapter describes the research methodology of this quantitative study. This study employed a cross-sectional survey design to accumulate statistics from companies. The survey was conducted online, using a web-based questionnaire, and distributed to organizations through e-mail. The questionnaire comprised of four sections: information systems, e-techniques, and carbon reduction strategies. A five-point Likert scale was used to assess the responses of respondents. The study population consisted of organizations that have implemented or planned to implement carbon reduction strategies. A convenience sampling technique was used to select the study sample. A total of 500 Chinese construction firms were contacted, and 470 responded, yielding a response rate of 94%. Data analysis was conducted using Structural Equation Modeling (SEM) with SmartPLS software. SEM was used to test the proposed conceptual model and examine the relationships among the variables.

Demographic Profile of Respondents

The descriptive statistic shows that 45.7% (215) of the respondents were male whereas 54.3% (225) of the respondents were female. The age of 135 respondents (28.7%) were 25-34, and 240 respondents were from the age group of 35-44 which is 51.1%. 14.9% of respondents were from the 45-55 years age group and the remaining 5.3% of respondents were over 55 years. The education level of the majority of the respondents (64.9%) was master while 9.6% had a bachelor's degree and the remaining 25.5% respondents had doctoral degrees. The majority of the respondents (42.6%) had less than 5 years of experience in construction projects. 36.2% of respondents have 5-10 years of experience in construction projects while 21.3% of respondents have more than 10 years of experience. In terms of job position, 28% were project managers, 10% were architects, 19% were engineers, 11% were contractors, 18% were laborers, and 14% were others. Information systems that were used by these construction projects were BIM (30.8%), GIS (35.5%), project management software (26.6%) and the remaining 7.02% used other construction projects. **Table 1** shows the demographic profile of the respondents.

Table 1. Demographic Profile of the Respondents

Demographic item		Frequency	Percentage
Gender	Male	215	45.7%
	Female	255	54.3%
Age	25-34	135	28.7%
	35-44	240	51.1%
	45-54	70	14.9%
	Over 55	25	5.3%

Demographic item		Frequency	Percentage
Education level	Bachelor's degree	45	9.6%
	Master's degree	305	64.9%
	Doctoral degree	120	25.5%
Years of experience in the construction industry	Less than 5 years	200	42.6%
	5-10 years	170	36.2%
	More than 10 years	100	21.3%
Job position/role in the construction project	Project manager	132	28%
	Architect	48	10%
	Engineer	88	19%
	Contractor	50	11%
	Laborer	84	18%
	Other	68	14%
Type of information systems used in the construction project	Building Information Modeling (BIM)	145	30.85%
	Geographic Information Systems (GIS)	167	35.53%
	Project Management Software	125	26.60%
	Other	33	7.02%

RESULTS

The reliability and validity of the scales were evaluated making use of Confirmatory Factor Analysis (CFA), which was performed with SmartPLS. It is advised to utilize SmartPLS because statistically speaking, it performs better than other statistical programs that are used in covariance-based structural equation modeling, and it is less susceptible to sample size (Zaman, Nawaz, Javed, & Rasul, 2020). In addition, SmartPLS has less of an impact on the results when larger samples are employed. Before commencing the whole data analysis, we made sure that each concept met our standards for validity and reliability (Hair, Sarstedt, & Ringle, 2019). Prior to carrying out the SEM analysis, a measure modeling analysis technique was utilized in order to undertake validity and reliability checks on each individual construct. Study data analysis included Average Variance Extracted (AVE), factor loading, Cronbach's alpha, and composite reliability (Javed, J. Iqbal, S. M. J. Iqbal, & Imran, 2021). Factor loading surpassed 0.40 for each item. Hair, Sarstedt, & Ringle (2019) found composite reliability criteria, Cronbach's alpha, and rho A above 0.70. Convergent validity was assessed using AVE. Each building must have an AVE greater than 0.5. **Table 2** and **Figure 2** show that factor loading statistics exceed the 0.4 criteria by a large margin. Both composite and Cronbach's alpha scores are above 0.70, suggesting all dependability indicators are satisfactory. AVE > 0.5 indicates that the study's measuring tool was valid and reliable.

Table 2. Construct Reliability and Validity

	Items	Outer Loading	VIF	Cronbach's Alpha	CR	AVE
Carbon reduction strategies	CRS1	0.879	3.332	0.811	0.856	0.505
	CRS2	0.860	3.172			
	CRS3	0.601	1.770			
	CRS4	0.645	1.737			
	CRS5	0.637	2.212			
	CRS6	0.579	1.366			
E-techniques	ET1	0.699	1.919	0.910	0.925	0.553
	ET10	0.739	3.792			
	ET2	0.723	3.439			
	ET3	0.725	3.446			
	ET4	0.734	2.733			
	ET5	0.823	2.846			
	ET6	0.685	1.924			

	Items	Outer Loading	VIF	Cronbach's Alpha	CR	AVE
	ET7	0.752	2.584			
	ET8	0.802	3.215			
	ET9	0.743	3.879			
Information systems	IS1	0.807	2.648	0.897	0.916	0.579
	IS2	0.732	1.911			
	IS3	0.768	3.076			
	IS4	0.793	3.253			
	IS5	0.724	3.341			
	IS6	0.796	3.906			
	IS7	0.808	3.860			
	IS8	0.647	2.703			
Project complexity	PC1	0.904	3.122	0.847	0.885	0.612
	PC2	0.761	1.695			
	PC3	0.730	2.372			
	PC4	0.887	2.893			
	PC5	0.587	1.992			
Project orientation	PO1	0.627	1.415	0.779	0.852	0.541
	PO2	0.553	1.320			
	PO3	0.786	1.964			
	PO4	0.838	2.342			
	PO5	0.828	2.335			

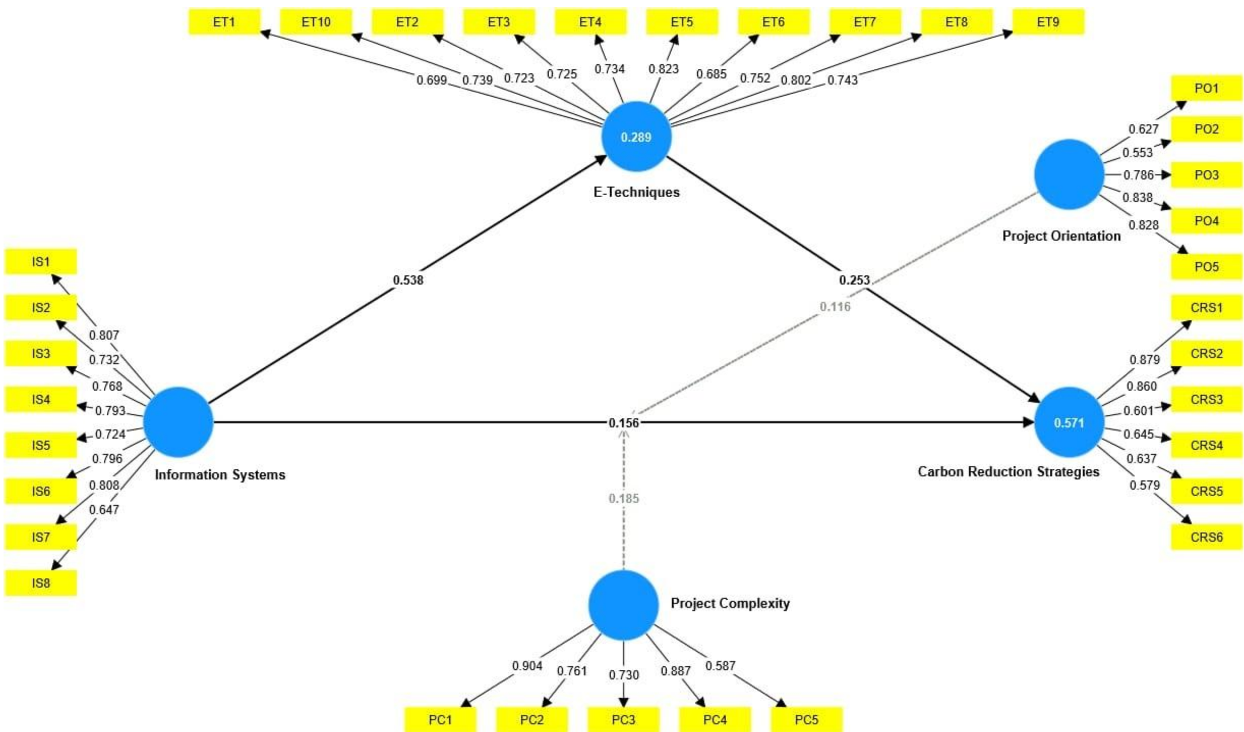

Figure 2. Measurement Model

A metric known as discriminant validity is applied to determine whether or not a research model is able to differentiate between two or more distinct constructs of interest (Yang et al., 2022). This illustrates the extent to which the questions or tests that are designed to evaluate a certain construct really assess a model construct. The component correlations are determined by Fornell-Larcker and the square root of the AVE for each construct is compared to these component correlations. For a construct to have discriminant validity, the square root of the AVE for that construct needs to be larger than the correlation it has with the other parts of the model. This is how discriminant validity is demonstrated. The test's ability to differentiate across groups is outlined in **Table 3**.

Table 3. Discriminant Validity (Fornell-Larcker criterion)

	CRS	ET	IS	PC	PO
Carbon reduction strategies	0.710				
E-techniques	0.483	0.744			
Information systems	0.418	0.538	0.761		
Project complexity	0.439	0.479	0.266	0.782	
Project orientation	0.714	0.733	0.481	0.468	0.736

These methods include the heterotrait-monotrait (HTMT) correlation ratio, which SmartPLS 4 offers. HTMT is heterotrait-monotrait correlation ratio. This method compares the correlation between the components of both constructions to the correlation between them. The HTMT ratio can indicate discriminant validity by comparing it to 0.9. This can be done in a practical manner. The results of the HTMT are detailed in **Table 4**.

Table 4. Discriminant Validity (HTMT)

	CRS	ET	IS	PC	PO
Carbon reduction strategies					
E-techniques	0.510				
Information systems	0.501	0.578			
Project complexity	0.446	0.497	0.270		
Project orientation	0.815	0.887	0.576	0.506	

The H1 relationship's findings, which indicated that information systems have a significant and positive impact on carbon reduction strategies, support this hypothesis (t = 3.370, P = 0.0001). According to the H2 relationship's findings, the hypothesis that information system has a significant and positive impact on e-techniques is accepted (t = 16.923, P = 0.0001). According to the H3 relationship's findings, the hypothesis that e-techniques have a significant and positive impact on carbon reduction strategies is accepted (t = 26.914, P = 0.0001). **Table 5** and **Figure 3** show the result of the structural model.

Table 5. Summary of the Structural Model

Constructs	Path coefficient	t-statistics	p-values
Information systems -> Carbon reduction strategies	0.156	3.370	0.0001
Information systems -> E-techniques	0.538	16.923	0.0001
E-techniques -> Carbon reduction strategies	0.253	3.858	0.0001

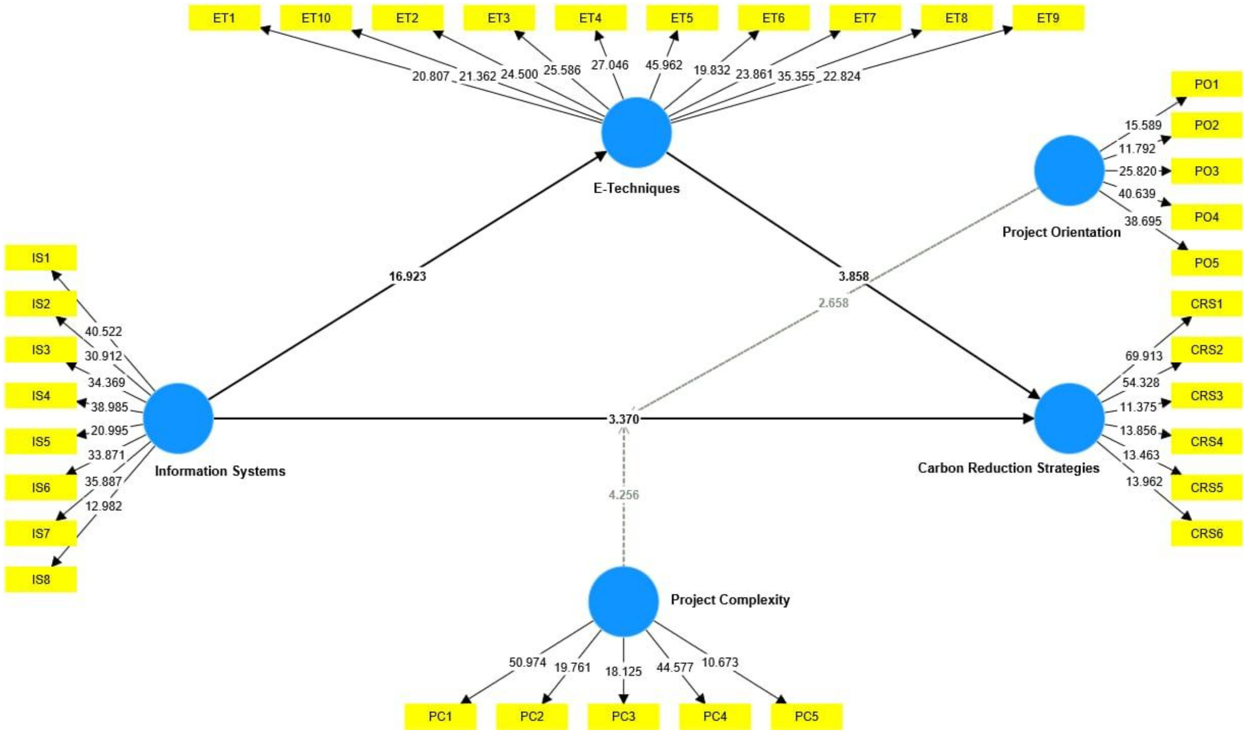

Figure 3. Structural Model

To determine if e-techniques mediated the relationships between the information system and carbon reduction strategies, the mediating effect of subjectivity was examined (β = 0.136, t = 3.772, p = 0.0001) (**Table 6**).

Table 6. Mediation Analysis

	Original Sample	T Values	P Values
Information Systems -> E-Techniques -> CRS	0.136	3.772	0.0001

To determine if project complexity and project orientation moderated the relationships between the information system and carbon reduction strategies, the moderating effect of project complexity and project orientation were examined (β = 0.185, t = 4.256, p = 0.0001: β= 0.116, t = 2.658, p = 0.004). **Table 7**, **Figure 4** and **Figure 5** shows the result of the moderation analysis.

Table 7. Moderation Analysis

	Original Sample	T Values	P Values
Project Complexity x IS -> CRS	0.185	4.256	0.0001
Project Orientation x IS -> CRS	0.116	2.658	0.004

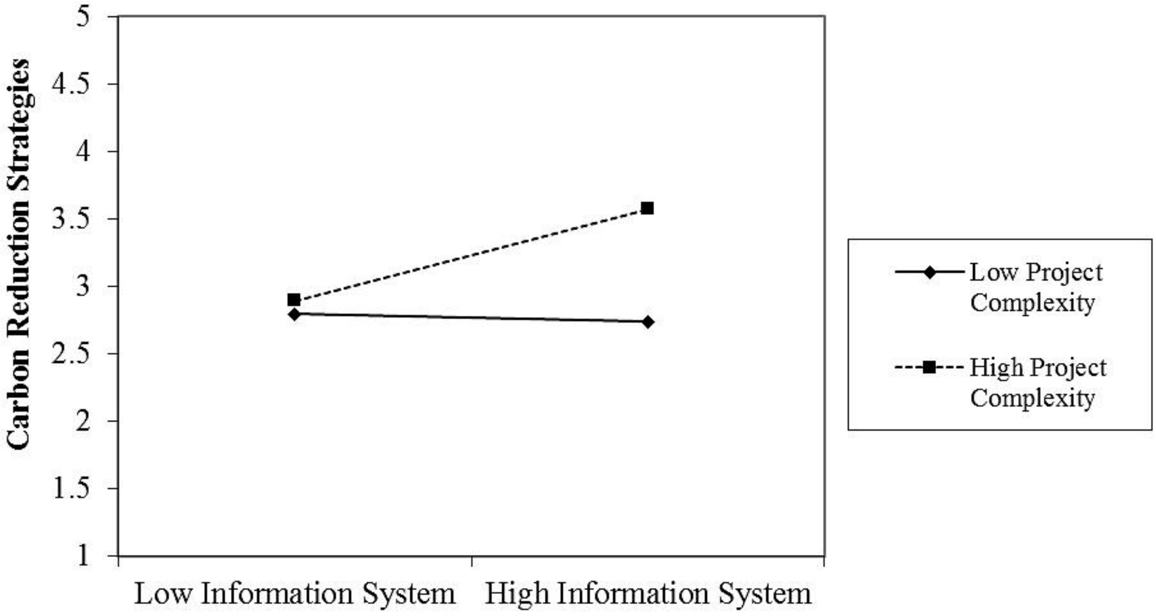

Figure 4. Moderation Analysis of Project Complexity

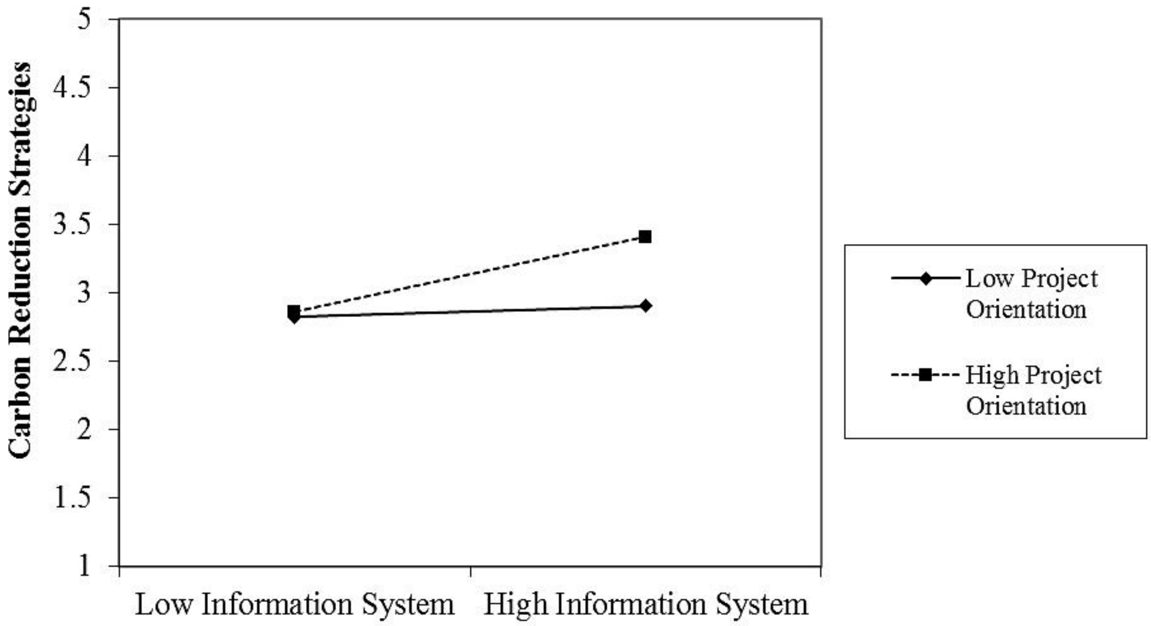

Figure 5. Moderation Analysis of Project Orientation

DISCUSSION

The first hypothesis is to investigate the impact of information systems on carbon reduction strategies. Information systems, which employ computers and software to manage and analyze data, have a positive influence on carbon reduction (Ding, Ward, & Tukker, 2023). This technology helps firms establish and implement carbon-reduction initiatives by identifying energy inefficiencies and waste. Companies may utilize information systems to gather, analyze, and use data. Infosystems can cut carbon emissions by building energy management systems. A real-time Energy Management System (EMS) may alert customers when energy usage exceeds criteria. This may help organizations quickly find and solve energy inefficiencies, decreasing carbon emissions and energy waste (Zhang & Luo, 2022). Data analytics is another way IT may help reduce carbon emissions. Organizations can uncover development opportunities and energy usage patterns by examining energy consumption data. Data analytics can identify energy-wasting equipment to boost equipment efficiency (Zheng &

Wang, 2021). Organizations may track and document carbon emissions via information systems. Companies may use software to collect and analyze energy use data to calculate and report their carbon footprint. This increases transparency and drives companies to reduce carbon emissions.

The second hypothesis examines how information systems affect electrical technology. IS is vital to ET uptake and utilization. "ET" refers to using technology and electronic devices to improve business and external communication, cooperation, and operations. IS can benefit ET in several ways (Cherukunnath & Singh, 2022). ET implementation begins with information systems providing the framework. Project management software, instant messaging, video conferencing, and email work best with reliable information systems. These systems give organizations with hardware, software, and network infrastructure to leverage these technologies, enhancing corporate collaboration and communication. Data management, storage, and retrieval need information systems (Toktaş-Palut, Baylav, Teoman, & Altunbey 2014). ET relies on data and information availability, whereas IS offers the infrastructure to acquire, store, and retrieve it. Information systems help companies manage their data and information, giving employees instant access to the information they need. Business process automation is crucial to enterprise transformation, which it facilitates. IS may automate tedious processes so personnel can focus on critical tasks that require their expertise. Information system implementation uses RPA, AI, and ML to automate procedures (Solainayagi et al., 2022). Information Security (IS) gives Essential Technologies (ET) security and privacy architecture. More technological tools and technology increase the risk of cyberattacks and data breaches. Information security policies and solutions safeguard company data from unauthorized access, hacking, and other online dangers (Kumar, Amin, & Brindha, 2023).

The third hypothesis examines how e-techniques affect carbon reduction. Electronic devices and digitization have permeated many organizations. These methods have greatly improved carbon reduction. Carbon emission reduction methods aim to reduce environmental damage (Wang et al., 2021). E-technologies reduce energy and paper use in typical corporate procedures, helping achieve this goal. Paper manufacturing and transportation cause carbon emissions and deforestation, although digital storage and documentation mitigate this (Jianlong Wang, Liu, Wang, & Wu, 2023). Digitalization also streamlines operations, reducing energy use and carbon impact. E-technologies enable virtual meetings and remote work while reducing travel and carbon emissions (Yuan, Feng, Li, & Sun, 2022). Remote working has become more relevant since the COVID-19 pandemic drove many companies to embrace it. Electro techniques significantly improve carbon emission reduction efforts. It helps firms achieve sustainability goals by lowering typical company carbon emissions. Given the increasing pace of technology, enterprises must adapt and incorporate electronic approaches into their operational procedures to survive (Zhang, Xiong, Yang, & Yu, 2023).

The fourth hypothesis questions how e-techniques combine information systems with carbon reduction. Businesses use IS to manage carbon reduction projects to lower their carbon impact. The technique used to link information systems with carbon emission reduction may not be clear (Kumari & Pandey, 2023). A recent study suggests that e-techniques, tools, and platforms can help control and minimize energy use. IT and carbon-reduction measures may be affected. Automatic energy management, smart metering, and real-time energy consumption monitoring are examples (Ahmed et al., 2018). E-techniques provide real-time energy statistics. This data can help uncover energy-saving and carbon-reduction options. Smart meter data helps companies identify energy-intensive equipment and processes and conserve energy (Pei et al., 2023). E-techniques may automate energy management by turning off lights and other equipment, regulating heating and cooling systems, and scheduling energy-intensive operations during off-peak hours. Automation can boost efficiency and reduce energy waste for businesses (Hireche, Benzaïd, & Taleb, 2022).

The fifth hypothesis examines what project direction does to information systems and carbon reduction. Ajiboye, Popoola, Adewuyi, Atayero, and Adebisi (2022) evaluated how project methodology and management impact carbon reduction program outcomes and information systems. Information technology's carbon emission reduction potential may depend on project planning and execution. Pathak, Sharma, and Ramakrishna (2023) found that information systems minimize carbon emissions better when the project prioritizes sustainability. This may include incorporating sustainability into decision-making and recognizing and mitigating the company's specific negative environmental effects. However, a project orientation focused on efficiency or cost reduction may not prioritize carbon reduction (Ding et al., 2023). Information technology may be used to optimize commercial operations without addressing environmental effects. Due to larger difficulties, limiting carbon emissions may be impossible. According to the statement, project orientation and management should be taken into account when designing information systems expressly for carbon reduction initiatives. When firms prioritize environmental and sustainability goals, information systems can help foster a sustainable future (Raihan, 2023).

The sixth hypothesis: project complexity influences information systems and carbon-reduction methods. Information technology may minimize carbon emissions depending on project complexity. Information systems and carbon reduction methods perform differently depending on complexity. For complicated projects, utilize stronger information management and monitoring tools. Complex projects require stakeholder collaboration and communication, which information systems can improve (Swain, Williams, Di Felice, & Hobson, 2022). Project complexity may weaken the relationship between information systems and carbon reduction. Information systems may not be effective if they are not integrated with other project management tools or cannot handle project complexity (Onate-Vega, Oviedo-Trespalacios, & King, 2020). When reviewing project specifics, carbon reduction information systems are essential. Information systems may minimize carbon emissions in different ways for different projects (Sampaio & Barbosa, 2016).

CONCLUSION

The moderating impacts of e-techniques, project orientation, and information systems were explored in the study. The study found that information systems, particularly those using e-techniques, may help carbon reduction efforts. The study found that project complexity and direction might affect the interaction between information systems and carbon reduction measures, limiting their usefulness. The study illuminates information systems' ability to address environmental issues like carbon reduction. It emphasizes project orientation and complexity while building such systems. This study may help practitioners, administrators, and politicians create and implement effective information systems for sustainable development and environmental protection. Adding aspects that affect the interaction between information systems and carbon reduction measures may improve understanding and execution.

IMPLICATIONS

Theoretical Implications

Investigation of the complex interaction between data frameworks and carbon diminishment programs appears hypothetical complexities, uncovering how innovation and environmental maintainability are connected. The exposition stresses the significance of electronic innovation in making a difference in companies lowering their carbon effect. The report emphasizes the requirement of utilizing innovation to advance maintainability, especially electronic technologies' effect on carbon diminishment. Data frameworks, e-technologies, and carbon-reduction measures associated with shaping the project's complexity and course. This exhaustive understanding underscores the need for technology-focused supportability measures. The investigation uncovers directing factors that underline the challenges of decreasing carbon emanations with data innovation. This ponder appears to the challenges of maintainability execution and thinking. It appears that data frameworks and e-technologies may cut carbon outflows and advance maintainability. This project's heading and complexity illustrate the need for versatile data frameworks and electronic arrangements to effectively minimize carbon outflows.

Practical Implications

The study's discoveries make strides in hypothetical understanding and give a down-to-earth guide for carbon outflow decrease endeavors. It stresses the significance of contributing to e-technologies and data frameworks to quicken carbon-lessening endeavors. Supportability detailing, vitality administration, and carbon bookkeeping are vital goals within the content. Innovation quickens carbon outflow diminishment and increments natural stewardship straightforwardness and responsibility. The study also emphasizes the importance of aligning information systems and e-technologies with individual initiatives' trajectory and complexity to reduce carbon emissions. Agile project management solutions are suggested for project-focused businesses since they adapt quickly. Complex projects require large resources and industry specialists to properly implement carbon reduction plans. Understanding the complicated interplay between project requirements and technology implementation helps organizations navigate sustainability efforts. The research stresses staff participation and training in establishing and using electronic technologies and information systems to reduce carbon emissions. User proficiency and devotion are vital to the success of new technology; hence the research suggests substantial training programs for staff. Creating an ecological attitude and encouraging carbon reduction targets is essential to the success of technology solutions in the workplace.

LIMITATIONS AND FUTURE DIRECTIONS

Limitations

Although this study offers insightful records of approximately how e-strategies are utilized in a particular zone of the economic system and area, its restricted generalizability might also make it tough to use the effects in different sectors or areas. The have a look move-sectional design may make it difficult to set up causal hyperlinks. The use of self-pronounced statistics increases the threat of response biases such as the social desirability bias, that can affect the reliability of the findings. Furthermore, the study's use of a constrained set of metrics to evaluate e-techniques might not fully reflect the variety of methods used by firms.

Future Directions

Future studies can use a variety of methodological approaches to improve our understanding of the intricate connections between information systems, carbon reduction methods, e-techniques, project orientation, and project complexity. Longitudinal investigations illuminate the processes that link these factors. A broad research spanning sectors and geographies may have wider application. Mixed-methodology research combines quantitative and qualitative methods to better understand the subject. Blockchain's impact on carbon reduction needs further study. Analyzing moderating elements including external conditions, leadership, and business culture can help explain how information systems affect carbon reduction projects. These analytical methods can help future researchers grasp the complicated links between project orientation, information systems, carbon reduction strategies, e-techniques, and project complexity.

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