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DEVELOPMENT OF A CONCEPTUAL FRAMEWORK FOR STRATEGIC IMPLEMENTATION OF ZERO CARBON INITIATIVES IN THE UAE CONSTRUCTION INDUSTRY; METHODOLOGICAL CHOICES

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Abstract

Carbon reduction initiatives cannot be implemented unless and until, main workplace processes have been dealt with to similar standards. This study critically evaluates the strategic implementation of environmental management systems in the United Arab Emirates (UAE) construction industry and their contribution to zero carbon goals. As part of robust management systems, it is argued that generic best practice simultaneously promotes optimum outcomes in both – they are mutual and not independent of each other. The study adopted a quantitative research method approach. A questionnaire survey was conducted, with responses from 106 UAE construction professionals. There is emphasis in the research on the value of soft-systems research methodologies (non-technical) as a tool to investigate environmental problems rather than scientific or technical approaches. The findings indicate that reviews, audits, and evaluations are essential for projects to sustain their specialist competence. These mechanisms assist project managers in navigating the evolving landscape of industry by leveraging accumulated expertise. Common challenges include a lack of clarity and executing tasks in an unordered manner, which can impede construction effectiveness. Tech-driven solutions have been embraced to bolster workplace sustainability and enhance service standards. Boosting service excellence involves refining operations and side-stepping mistakes. Technical and non-technical research methodologies are equally valid in enhancing environmental and zero carbon outcomes.

Keywords: Climate change, Construction, Development， Low-Carbon, Next keyword, Sustainability Goals.

1. Introduction

Society needs to contend with the significant consequences of climate change, including rising sea levels, more frequent and severe natural disasters, and global warming [1]. Human activities have markedly increased greenhouse gas (GHG) emissions since the Industrial Revolution [2]. The 2016 Paris Agreement aims to limit global warming to no more than 1.5 °C above pre-industrial levels, prompting a call to action from various private and public-sector entities to swiftly implement strategies for enhanced carbon reduction [3].

The construction industry, responsible for one-third of global GHG emissions [4], plays a vital role in addressing anthropogenic climate change and environmental impacts. Achieving a net-zero carbon target in this industry requires substantial changes in practice, encompassing the adoption of low-carbon designs and technologies during construction project planning and implementation, along with increased integration within construction supply chains. The public sector has significant influence in promoting change, and thus, central and local governments serve as effective drivers for encouraging carbon reduction initiatives.

In recent years, there has been a growing emphasis on construction procurement as a policy tool to achieve net-zero carbon goals and sustainable development objectives in the public sector. One approach to reducing construction carbon emissions through procurement involves encouraging tendering parties to identify opportunities for carbon reductions, offering a bid price advantage linked to carbon savings [5]. This could include preferences for low-carbon construction materials and processes specified in tender documents. Crucial considerations include well-defined targets and functional requirements for operational energy use, transportation of materials to sites, and choice of energy sources for construction equipment and activities [6].

Research in this field is emerging, with many studies published on green public procurement (GPP) and low-carbon public procurement (LCPP) over the last decade [7]. GPP defines a process where public authorities procure goods and services with lower environmental impact than alternatives with comparable function and performance [8]. In comparison, LCPP means using procurement processes to mitigate carbon emissions from public purchases. Extensive research has concentrated on mapping the practices of green and sustainable procurement in construction globally [9].

However, conditions differ substantially between different sustainability goals and local contexts, leading to inconsistent and ambiguous understanding and analysis of factors that drive procurement development in areas such as carbon reduction. Moreover, sustainable construction can be considered a broad term within the general context of holistic sustainability, while low/zero-carbon construction focuses specifically on the operational or life cycle carbon-based knowledge area.

The practical integration of carbon reduction into construction procurement in the UAE remains an understudied area [10]. Despite an extensive search in databases like Scopus and Web of Science using key terms such as 'zero carbon', 'low carbon,' and 'construction procurement' in the context of the UAE, no publications were found on the subject. Differences in environmental, cultural, political, economic, and social aspects make findings from other countries often irrelevant to the UAE. The nation's status as a small-to-medium developed

economy with an important strategic location supports well-established construction supply chains.

The recent emphasis on maximizing carbon reduction in the UAE's construction industry is notable [11]. Delays in promoting zero-carbon legislation have resulted in lags in other developed countries, offering the UAE an opportunity to learn valuable lessons within its unique context [12]. However, these delays pose challenges to the effective implementation of carbon reduction strategies in construction procurement.

This study addresses this gap by investigating carbon reduction strategies in UAE's construction procurement systems, specifically targeting procurement of work with lower life cycle carbon emissions. The methodology includes an extensive literature review to identify relevant strategies globally and in the UAE context. Adopting a quantitative research design, the study also conducted a questionnaire survey with responses from UAE industry professionals. The subsequent reporting of results and recommendations focuses on three main themes:

- The current application of carbon reduction strategies in construction procurement.
- Suggestions for improving their implementation.
- Challenges in implementing these strategies.

This research aims to investigate ways for the UAE to achieve zero emissions and biodiversity goals, and to raise civil society awareness about carbon impacts and environmental action. Commitments set out in the climate and environment charter provide a set of conceptual frameworks for the strategic implementation of zero carbon initiatives. To implement these commitments, organisations should set specific, measurable goals and draw up action plans that define how they intend to achieve those goals.

The objectives and methods of this research are to, in the context of the UAE:

i. Critically appraise the extent to which information is available and transparent for zero carbon initiatives (variable 1 – VAR 1),

ii. Determine practitioners' judgements about the extent to which construction companies comply with international best practices in the application of zero carbon initiatives (variable 2 – VAR 2), and

iii. test for a relationship between these variables. The method is a literature review, questionnaire survey and descriptive/inferential statistical analysis.

2. Zero Carbon Initiatives in UAE

The development of legislation and schemes to improve the implementation of zero carbon initiatives has led to the rethinking of UAE's key goals [13]. The climate crisis is already affecting lives and the way people work; climate change and the transition to a climate-neutral future are creating new industries and business growth opportunities. The National Carbon Register is an important platform for tracking greenhouse gas emissions and taking measures to reduce them, including accelerated financing solutions [14, 15].

Carbon reduction initiatives cannot be implemented unless main workplace processes have been dealt with to similar standards. Anyone attempting to deal with reducing carbon in construction as a separate issue, soon finds that it is ephemeral,

and it has no substance that prevents it from drifting away unless it is firmly anchored to the realities of work activities or processes.

2.1. UAE climate action plan

In the UAE, comprehensive construction procurement guidelines offer guidance to construction stakeholders for the successful implementation of optimal practice [16]. They outline standard procurement processes, encompassing planning, sourcing, and management. While lacking specific practical examples and details, the guidelines do underscore critical success factors for procurement processes, such as strategic priorities, leadership and management, stakeholder engagement, capability and capacity, project team integration, and market understanding.

Concurrently, the UAE Ministry of Climate Change and Environment is actively collaborating with public and private sector partners to enhance initiatives addressing climate change, with a focus on both mitigation and adaptation [17]. This commitment is evident in initiatives such as the National Climate Change Plan 2050, sanctioned by the Cabinet in June 2017, and the National Climate Change Adaptation Program, adopted during the first annual meeting of the UAE Government in September 2017 [18]. The timeline of UAE the Climate Action Plan is illustrated in Fig. 1.

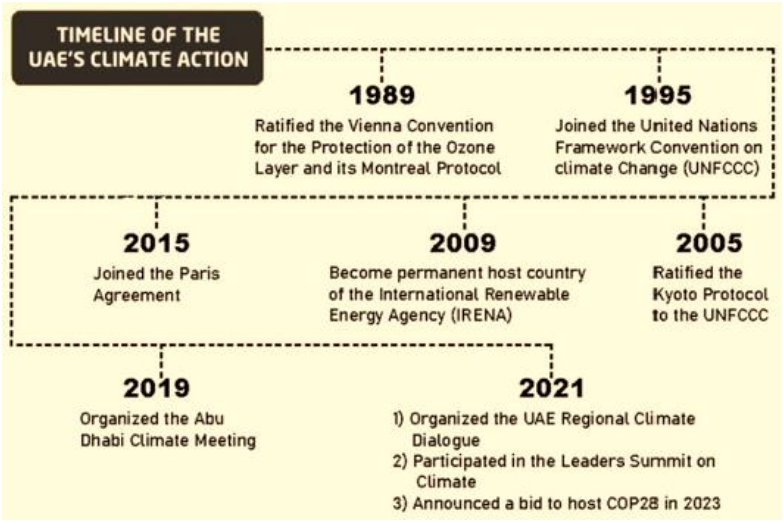

Fig. 1. Timeline of UAE climate action plan (www.mocca.gov.ae).

UAE's strategic initiatives, aiming for Net Zero by 2050, represent a nationwide push to position the UAE as the first MENA nation to attain this target [19]. A roadmap for accelerating national economic development during the golden jubilee year marks the beginning of a new 50-year growth cycle [20]. The pursuit of net zero presents substantial economic opportunities, supporting the vision of developing the Emirates into the world's most dynamic economy. In line with the Paris Agreement [18], the UAE Net Zero 2050 initiative focuses on deploying and utilising clean energy solutions [21].

With a history of investing over 40 billion USD in clean energy projects, the UAE anticipates a significant increase in clean energy production capacity,

including solar and nuclear, reaching 14 GW by 2030 [22]. The UAE is actively engaging in 14 projects under the Clean Development Mechanism (CDM) to reduce Greenhouse Gas (GHG) emissions, estimating an annual reduction of approximately one million tons of carbon dioxide equivalent. Positioned at the forefront of the clean energy revolution, the UAE demonstrates commitment by hosting the International Renewable Energy Agency (IRENA) and ratifying the Kyoto Protocol in 2005 [12].

While not obligated to reduce emissions as a non-Annex 1 country under the UNFCC, the UAE chooses to implement measures, including monitoring and evaluating GHG emissions and associated policies. The country is dedicated to expanding the role of low-carbon technologies, investing in renewable energy and nuclear power [23].

At the COP21 United Nations Climate Change Conference in December 2015, the UAE pledged to generate 24% of its electricity from clean energy sources by 2021. Actively monitoring and reducing its carbon footprint, the UAE achieved this through technological advancements and a transition to increased use of natural gas in power plants, thus resulting in reduced per capita carbon emissions [24].

2.2. Challenges impeding construction carbon reduction in the UAE

The UAE recently unveiled a comprehensive decarbonisation roadmap, marking a strategic pathway to carbon neutrality by 2050 [12]. This plan aims to significantly reduce carbon emissions within the built environment and set new benchmarks for urban centres. To facilitate this ambitious endeavour, a series of interim milestones have been established for the years 2030 and 2040 [25], each serving as a pivotal step towards minimising operational carbon and ultimately achieving the 2050 carbon neutrality goal. This roadmap is meticulously crafted to align with the 'Global Protocol for Community-Wide Greenhouse Gas Inventories,' ensuring compliance with internationally recognised guidelines, including those set by the Science-Based Targets Network, specifically tailored for urban decarbonisation.

Embracing the national motto 'Today for Tomorrow,' emblematic of the Year of Sustainability [26], the UAE's strategy is firmly rooted in reducing emissions across all sectors, building upon early successes in carbon management inaugurated during Expo 2020 Dubai [10]. Matt Brown, Head of Sustainability at Expo City Dubai, emphasises the city's model of sustainable urban living and its unwavering commitment to maximising social, environmental, and economic impacts. This commitment is underpinned by a comprehensive approach to addressing climate change, integrating the elimination of carbon in all aspects of operations and urban life, bolstering current policies, and pioneering new, innovative initiatives [27].

The UAE's strategy revolves around a threefold approach: reducing, eliminating, and compensating for carbon emissions [28]. This involves implementing measures to enhance energy and water efficiency, harnessing renewable energy, utilising low-carbon materials, and embedding circular economy principles. The UAE's strategy not only involves reducing carbon emissions across geographical and consumption-based stocks but also ensures the compensation of unavoidable emissions through strategic removal and compensation projects.

The alignment of the UAE's strategy with the Global Protocol for Community-Wide Greenhouse Gas Inventories, underscores a holistic approach to managing greenhouse gas emissions [16]. This approach transcends mere institutional

activities and encompasses broader impacts associated with urban growth and operations. Expo City upholds corporate accounting standards and reporting practices as detailed in guidelines set by the World Business Council for Sustainable Development and the World Resources Institute [29].

2.3. Carbon reduction plan

Amidst the various challenges hindering the incorporation of procurement systems related to carbon reduction, there exist opportunities for the implementation of policies, guidance, and tools [30]. The UAE serves as an example, having established targets, baselines, and outcome specifications to gauge carbon impacts in procurement [31]. A collaborative effort between clients and contractors is emphasised [32]. However, issues arise in striking a balance between low-carbon designs and demanding requirements for high-carbon competence from contractors. Notably, a significant public transportation agency in the UAE has formulated sustainable design guidelines that integrate functional carbon reduction requirements into the procurement process [33], yet non-compliance incurs no penalties.

Moving beyond governmental guidance, supportive policy instruments like standards and labelling programs have the potential to facilitate carbon reduction-related procurement. Examples include LEED, BREEAM, Estidama, and the CO_2 Performance Ladder, providing certification or labels affirming adherence to carbon and energy criteria. Incorporating instruments like energy efficiency labelling into the procurement process reduces costs and time [34].

However, challenges exist due to the recent introduction of carbon labelling and a lack of regulations governing calculation methods, potentially undermining the assurance of legitimate emissions reductions from products labelled as low carbon. Tools such as carbon accounting hold promise for integration into construction procurement [35]. Energy modelling tools forecast energy performance and operational carbon emissions for buildings, optimising design through detailed calculations of the operating energy required for a given performance [36].

Notably, while these tools can calculate operational carbon emissions associated with energy use, they fall short in accounting for the entire life cycle of embodied carbon. Life Cycle Assessment (LCA) emerges as a preferred method, aiming to evaluate potential environmental impacts of products and services. LCA considers cumulative impacts from raw material extraction to final disposal, yet its practical application in real-life scenarios remains limited despite its prevalence in establishing criteria within the construction industry [37].

2.4. Social variations in the sustainability of natural resources in UAE

The UAE is keen to enhance social responsibility and consolidate the idea of volunteer work in the environmental field in a way that raises the contribution of all members of society [38]. The Emirati experience is yielding many success stories driven by officials and attained in all segments of society as part of state efforts to enhance social responsibility. Academics in the Emirates play a major role in enhancing awareness among segments of society about local environmental issues and instilling a sense of responsibility towards environmental sustainability and preservation [39].

The 'National Sustainability' campaign was launched recently, coinciding with the preparations for the Conference of the Parties to the United Nations Framework

Convention on Climate Change (COP28) [40], held during November and December 2023 in Expo City Dubai; it was an ideal platform to showcase efforts of volunteers in environmental protection. It allocated a special focus to 'Climate Action Heroes,' with the aim of highlighting individual participation in innovative initiatives in the field of climate action [41].

The campaign aims to spread awareness about environmental sustainability and to encourage community participation. The Ministry of Climate Change and Environment also launched the 'Environmental Volunteering Portal' in 2017 [42] as one of its community participation initiatives. It aims to enhance the level of awareness in society and support the Ministry's strategic objectives to protect the environment and ensure the sustainability of natural resources and biodiversity [42].

In 2018, the Ministry also launched the first campaign at the state level, in which a group of media professionals, social media pioneers, and employees of government communication departments and federal and local departments participated in cleaning the desert environment [43]. In addition, the Environment Agency in Abu Dhabi provided the opportunity for people wishing to contribute to protecting the environment to volunteer in two programs through which they contribute to increasing social awareness and building a society that supports sustainable development goals. The first program, 'Green Citizen' involves protecting the UAE's natural heritage.

The second is the 'Environmental Monitor Program for Youth -Murshid,' in cooperation with the Emirates Foundation for School Education and the Department of Education and Knowledge in Abu Dhabi. Through the program, the Agency seeks to inspire and engage students who are committed and interested in protecting and preserving the environment. The program also provides opportunities to provide and receive guidance and leadership development, in addition to gaining experience in environmental education and enhancing youth efforts in the field of restoring ecosystems [43].

3. Research Methods

This section offers a comprehensive description of the study concurrent research methods. Concurrent quantitative method research design involves collecting data. The quantitative approach is described, with its definitions, strengths, and weaknesses; the philosophical assumptions underlying the quantitative methodology; and the appropriateness of the method chosen for the current study is examined. Also, the section describes procedures undertaken to identify the population of the study, and steps taken to select sample 'participants' and determine the sample size ‘106 participants from UAE construction professionals. It also describes participants in terms of age, nationality, level of education, type of work and other demographic variables. The section contains a description of the instruments used and explains how the researcher's ensured validity and reliability.

3.1. Study design and procedure

The research study is based on the quantitative method approach [44]. For this cross-sectional study, participants completed an online questionnaire sent through Google Forms. Convenience and non-probabilistic sampling were used based on accessibility to the study population and on their disposition to take part in the

research. This sampling technique was chosen considering that it is fast, economically reasonable, and adaptable to participant schedules [45]. Appropriate ethical protocols were followed. Respondents were invited through a verified inter-institutional mailing list shared among companies.

The survey was applied guaranteeing anonymity of the participants and advising data would only be used for research purposes. An informed consent statement was checked and accepted by participants as a requirement for their voluntary participation in the survey. The data was collected between May 2022 and December 2023. The importance of answering honestly to all the questions was emphasised, as well as the non-existence of wrong or right answers.

3.2. Description of the questionnaire

The structured questionnaire was administered in English. It consisted of two main sections; the first part of the instrument asked about individual and demographic variables, such as age, qualification, and experience. The second part was used to measure two variables (VARs). Thus, VAR 1 is the extent to which information is available and transparent about zero carbon initiatives, and VAR 2 is practitioners' judgements about the extent to which construction companies comply with best international practices in the application of zero carbon initiatives.

Each variable is measured using a multiple-item scale, both with ten statements, as indicated in Tables 1 and 2. Questions are based on issues in the literature. A six wide Likert type scale was used, where respondents were asked the extent to which they agreed or disagreed with each individual statement.

Codes or scores were attributed to answers thus: very strongly agree 5, strongly agree 4, agree 3, disagree 2, strongly disagree 1, very strongly disagree zero and not sure was assigned mean value. Scores for each respondent were summed and, for ease of analysis, converted to a percentage scale. Since there were ten questions to measure each variable, the maximum score that could be achieved by individual respondents was 10 * 5 = 50, and the minimum score was 10 * 0 = 0. Thus, for example, a score of 35 out of 50 expressed as a percentage became 35/50*100 = 70%. Means scores expressed in percentages were calculated arising from the results of all respondents.

For VAR 1, high scores approaching 100% indicate extraordinarily strong agreement; practitioners judge the extent to which information is available and transparent about zero carbon initiatives is extremely high; low scores approaching 0% indicate exceptionally low agreement. Similarly, for VAR 2, high scores indicate extraordinarily strong agreement; practitioners' judgements about the extent to which construction companies comply with best international practice in the application of zero carbon initiatives are extremely high; low scores indicate exceptionally low agreement.

Additionally, further descriptive statistics are calculated, such as median, mode, minimum, maximum, range, and standard deviations, though these are not reported in this paper for brevity; none of the results were 'unusual.' The answers to each of the ten questions were ranked in order. An inferential Spearman's Rho correlation coefficient was calculated to test the hypothesis that there is a relationship between the two variables.

Table 1. Ten statements to which respondents indicated the extent to which they agreed or disagreed about the extent to which information is available and transparent about zero carbon initiatives (OB1).

Rank Order	Questions	Mean Scores
1	There is an internal zero carbon initiatives department responsible for reporting regularly and transparently	72.00%
2	There is coordination and cooperation with government agencies in the performance of zero carbon initiatives in the construction industry	71.40%
3	There are records of all zero carbon initiatives that are easily accessible	68.80%
4	There are many posters to publicise potential carbon emissions risks and hazards	68.80%
5	Carbon emissions reports are carefully examined to help prevent similar accidents from occurring	68.40%
6	There is a formal and approved training program and carbon emissions induction training for all professionals	67.60%
7	There is good knowledge of the benefits of following zero carbon initiatives	65.60%
8	There is easy access to carbon initiative information to support periodic assessments	65.40%
9	There are clear instructions stating how to reduce carbon emissions.	64.00%
10	There is a clear mechanism for risk assessments on site.	59.00%
	Overall Mean	67.10%

Table 2. Ten statements to which respondents indicated the extent to which they agreed or disagreed about the extent to which construction companies comply with best international practice in the application of zero carbon initiatives (OB2).

Rank Order	Questions	Mean Scores
1	There are clear roles and responsibilities for designated environmental functions	70.80%
2	Environmental management is relied upon to implement zero carbon initiative practices	67.40%
3	There are publicity posters to make people aware of environmental risks (carbon emissions)	67.20%
4	There is clarity in environmental procedures regarding carbon emissions	65.2%
5	There are risk assessments when there are potential environmental problems	64.60%
6	There is appropriate investment in work that may be required to protect the environment	63.80%
7	Professional staff are qualified in environmental management	63.40%
8	Waste materials of different kinds are kept in separate skips or areas before disposal off-site	61.60%
9	There are procedures to deal with ways of minimising carbon emissions	60.80%
10	Actions are taken to minimise the amount of carbon emissions created by site operations	56.40%
	Overall Mean	64.12%

3.3. Measures and design of the questionnaire

The questionnaire consisted of two main sections: The first part of the instrument asked about individual and demographic variables, such as age, qualification, and experience, whereas the second part consisted of 2 sets of 10 questions to cover two objectives of the study. Figure 2 illustrates the framework of the questionnaire design.

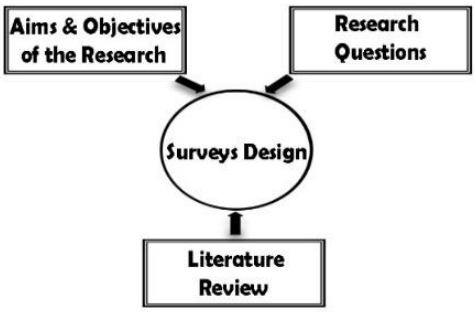

Fig. 2. Framework of the questionnaire design.

3.4. Methods of analysis (questionnaire data)

Descriptive analytical and statistical processes were executed on the data using Microsoft Excel and SPSS software. Mean, median, mode and standard deviation scores are the lead statistics. Confident research decisions are made using data quality solutions that help to understand questionnaire data and ensure accurate, consistent, and complete outcomes. Research success depends on accurate data for useful insights, but as data volumes grow, it becomes a significant challenge to understand, measure and monitor that data, including ensuring its fitness for purpose. Inaccurate, incomplete, and unavailable data diminishes the quality of research experiences.

Data analysis has taken on a heightened level of importance as the pace of change continues to accelerate and as new software and innovations appear. Quality data helps to resolve key problems and challenges. Causal comparisons guide decisions about association between variables by studying whether groups differ in their specific characteristics (usually independent variables) and differ in other characteristics (dependent variables) [46, 47].

4. Results and Discussion

To test the internal reliability of the scales, Cronbach's alpha was calculated; both scales gave scores more than 0.90 with a p-value of <0.05. Figures 3 and 4 indicate scores for individual respondents in class intervals. For VAR1, the range between the first and last ranked items is relatively narrow at 13.00% (72.00% item 1, minus 59.00% item 10). The range of mean scores for individual respondents is 38% to 100% with consequently a range of 62%. This range is again unusually large and would seem to indicate a difference in performance in companies. 'Excellent' performance is noted in some cases, with two scores above 98%.

For VAR 2, the first ranked variable in the multiple-item scale ('There are clear roles and responsibilities for designated environmental functions') scores far higher than others at 70.80%. The remaining nine variables have a relatively narrow range

of 11.00% (67.4% item 2, minus 56.40% item 10). The 7th ranked single question item for VAR 2, 'Professional staff are qualified in environmental management', scores 63.40% and is especially good.

The range of mean scores for individual respondents is 26% to 100% with consequently a range of 64%. This range is unusually large and would seem to indicate a difference in performance in companies. Two scores in the range of 26% to 38% are alarmingly low, although 'excellent' performance is also noted in some cases with scores above 86%.

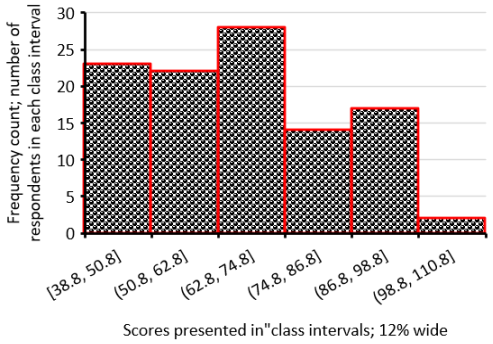

Fig. 3. Histogram to indicate individual respondents mean scores for variable 1 (VAR 1): the extent to which information is available and transparent about zero carbon initiatives.

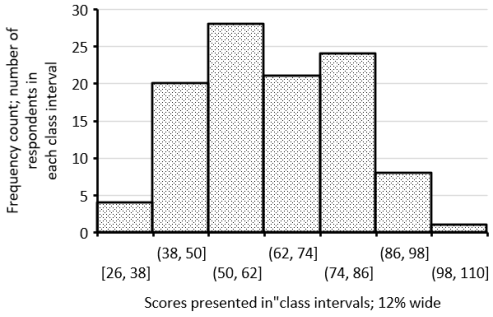

Fig. 4. Histogram to indicate individual respondents mean scores for variable 2 (VAR 2): the extent to which construction companies comply with best international practice in the application of zero carbon initiatives.

Spearman's Rho correlation was used to test the hypothesis that there is a relationship between the two variables. If the scatter line goes up from left to right, it indicates a fair, positive degree of relationship. Manipulating the IV up similarly moves the DV up (or manipulating the IV down similarly moves the DV down). Correlation coefficients are positive between 0 and 1. There may be outliers, and although the general spread may indicate a relationship, there may be one or two measures that are not consistent with the majority. Consideration may be given to whether such measures are spurious; they may be just bad or faulty data [48, 49].

For the two variables in this study, the calculation yielded a correlation coefficient of 0.27, indicating a fair degree of relationship between the variables,

with a p-value of <0.05. The scatter diagram is indicated in Fig. 5. The null hypothesis is rejected; the extent to which construction companies comply with international best practices in the application of zero carbon initiatives (VAR 1), influences the extent to which information is available and transparent about zero carbon initiatives (VAR 2).

Most importantly, it can be argued that the mean scores for both VARS 1 and 2 are also at the upper-medium level. In the context that both these items are of immediate concern internationally, 67.10% and 64.12%, respectively, indicate there is much room for improvement. Many individual items in these scales ought reasonably to be scoring much higher. It is worth citing the statement by Paul Morrell, Chief Construction Advisor to the UK Government [50] "We're going to need to start counting carbon as rigorously as we count money and accepting that a building is not of value if the pound signs look okay, but the carbon count does not".

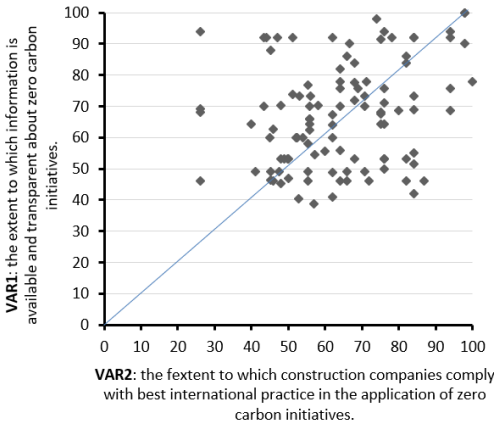

Fig. 5. Scatter plot to indicate the relationship between variables 1 and 2. Correlation coefficient 0.995, p-value < 0.05.

In the UAE construction industry, the mean for the two objectives, as formulated in the study, confirmed that although these practices are being followed, improvement is still needed to improve practice to reduce the carbon emission rates.

5. Conclusions

Based on the findings and implications of this research, several recommendations can be made for the UAE construction industry. There is a need for increased awareness and commitment to the importance of reducing carbon emissions and also, to increase awareness and understanding of the benefits and importance of effective environmental management practices. This could include providing training and education to employees, as well as promoting the adoption of environmentally friendly technologies and practices.

The extent to which information is available and transparent about zero carbon initiatives influences whether construction companies comply with best international practices in the application of zero carbon initiatives. Therefore, organisations should adopt an integrated approach to managing these two areas, which includes setting goals and targets to develop conceptual frameworks for strategic implementation. In the context of research methodologies, it is argued that

both technical and non-technical approaches are equally valid. Clearly technical, scientific and technology knowledge gain is imperative; non-technical human and social sciences research, as implemented in this paper, are also essential in driving forward investment and implementation.

Finally, organisations should adopt a culture of continuous improvement in carbon initiatives and environmental management. This includes regularly monitoring and measuring performance, setting targets for improvement, and implementing feedback mechanisms to identify areas for improvement. This will help organisations stay up to date with the latest best practices and ensure ongoing improvements in environmental performance.

Abbreviations

C2Eq	Carbon Dioxide Equivalent
CDM	Clean Development Mechanism
COP28	2023 United Nations Climate Change Conference
GHG	Greenhouse gases
GPP	Green Public Procurement
IRENA	International Renewable Energy Agency
LCA	Life Cycle Assessment
LCPP	Low-Carbon Public Procurement
UAE	United Arab Emirates
VAR1	Variable 1
Var2	Variable 2

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