From Estimator to Carbon Manager: Navigating Quantity Surveyors' Practice in Decarbonizing the Construction Industry

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ABSTRACT

The construction industry is a major contributor to global carbon emissions, making the implementation of decarbonization strategies critical for a sustainable future. Within this sector, Quantity Surveyors (QS) are uniquely positioned to influence sustainability outcomes through their traditional expertise in cost management, procurement, and contract administration. However, despite the growing emphasis on environmental sustainability, a significant gap persists between high-level policies and the daily operational practices of the surveying profession, particularly in regional corridors such as Sarawak. This study aims to examine the current practices, strategies, and challenges faced by quantity surveyors in Kuching, Sarawak, in facilitating a decarbonized construction industry. Adopting a quantitative research approach, data was collected via a questionnaire survey involving 89 professional quantity surveyors. The findings indicate that while industry practitioners recognize the importance of mitigating climate change and reducing carbon emissions, their operational effectiveness is constrained by structural barriers, specifically limited training, low awareness, and a lack of regulatory frameworks. The study reveals that quantity surveyors currently leverage pre-contract mechanisms such as e-tendering and life cycle costing (LCC) alongside post-contract measures like monitoring contractor compliance and reporting carbon footprints to drive decarbonization. To bridge the gap between sustainability policies and operational practice, the study recommends targeted government interventions, continuous professional upskilling, and the integration of digital tools such as Building Information Modelling (BIM). By adopting these strategies, quantity surveyors can strengthen their role in mitigating the environmental impact of construction activities and significantly contribute to steering the industry toward a net-zero future.

Keywords: Decarbonization, Quantity Surveying, Sustainable Construction, Carbon Management, Sarawak Construction Industry

INTRODUCTION

The construction industry is a major contributor to global greenhouse gas (GHG) emissions, accounting for approximately 38% of total energy-related carbon dioxide emissions. As Malaysia accelerates its commitments toward achieving net-zero carbon emissions by 2050, the role of construction professionals in driving decarbonization has become critical. Among these professionals, Quantity Surveyors (QS) are uniquely positioned to influence sustainability outcomes through their traditional expertise in cost management, procurement strategies, and contract administration.

Despite the growing global emphasis on sustainability, a significant gap persists between high-level environmental policies and the daily operational practices of the surveying profession. Recent literature indicates that while many quantity surveyors acknowledge the importance of environmental mitigation, there is a lack of practical integration of carbon management into pre-contract and post-contract workflows. Furthermore, much of the existing research on construction sustainability in Malaysia is heavily concentrated in metropolitan hubs such as the Klang Valley, leaving a notable empirical gap in regional corridors such as Sarawak. This study addresses this gap by examining the current practices, strategies, and challenges faced by quantity surveyors in Kuching, Sarawak, in facilitating a decarbonized construction industry.

The primary aim of this study is to examine quantity surveyors' practices in decarbonizing the future construction industry. Specifically, the research objectives are: (1) to explore decarbonizing strategies for the construction industry, (2) to identify quantity surveyors' current practices in decarbonization, and (3) to recommend improved practices for quantity surveyors to facilitate decarbonization.

LITERATURE REVIEW

Quantity Surveyors' Practices in Decarbonizing During Pre-Contract

The integration of decarbonization into the pre-contract stage represents a paradigm shift from traditional, cost-centric quantity surveying toward comprehensive carbon-cost management. Olanrewaju and Anahve (2015) assert that environmental considerations must be embedded at the earliest planning and design phases, necessitating quantity surveyors to evaluate innovative paradigms such as zero-waste designs, net-zero energy structures, and design-for-deconstruction principles. However, a critical analysis of these early-stage interventions reveals an inherent tension between initial capital outlays and long-term environmental dividends.

To bridge this analytical gap, Min (2017) highlights Life Cycle Costing (LCC) as an essential decision-making mechanism that enables quantity surveyors to systematically quantify the environmental impacts of alternative materials and forecast long-term operational cost savings. Building upon this economic foundation, Yun et al. (2023) emphasize that continuous updates to cost estimations are imperative when incorporating novel decarbonization techniques, as inaccurate upfront budgeting remains a primary catalyst for green project failure. Concurrently, the digitalization of the pre-contract environment through E-tendering serves a dual purpose; beyond administrative productivity gains, Hashim et al. (2020) argue that it structurally dismantles paper-based workflows, directly shrinking the carbon footprint associated with traditional tender documentation. Synthesizing these perspectives indicates that pre-contract decarbonization is not merely an additive task, but a fundamental restructuring of cost planning that requires multi-disciplinary foresight.

Quantity Surveyors' Practices in Decarbonizing During Post-Contract

While pre-contract strategies establish the theoretical framework for carbon reduction, the post-contract phase dictates whether these environmental targets materialize during physical construction execution. Shehu (2023) contends that quantity surveyors must transcend traditional financial accounting to actively monitor contractor operations, ensuring strict adherence to carbon reduction protocols and guiding on-site process improvements. This operational oversight is deeply intertwined with supply chain dynamics; Yun et al. (2023) argue that quantity surveyors must actively quantify embodied carbon and maintain empirical databases of low-carbon building products to successfully manage project carbon footprints.

Furthermore, the transition toward sustainable asset realization requires rigorous post-contract validation. Bolade-Oladepo et al. (2020) and Saka et al. (2019) emphasize that quantity surveyors play a decisive role in Building Rating Assessments and on-site material waste minimization, evaluating eco-friendly attributes such as recycled material content to secure green building certifications. Nevertheless, existing literature implies a critical vulnerability: post-contract carbon management often suffers from fragmented enforcement and a lack of standardized carbon-tracking metrics during interim valuations. Consequently, maximizing post-contract decarbonization efficacy necessitates a tighter contractual alignment between cost control, waste management, and real-time carbon performance reporting throughout the project lifecycle.

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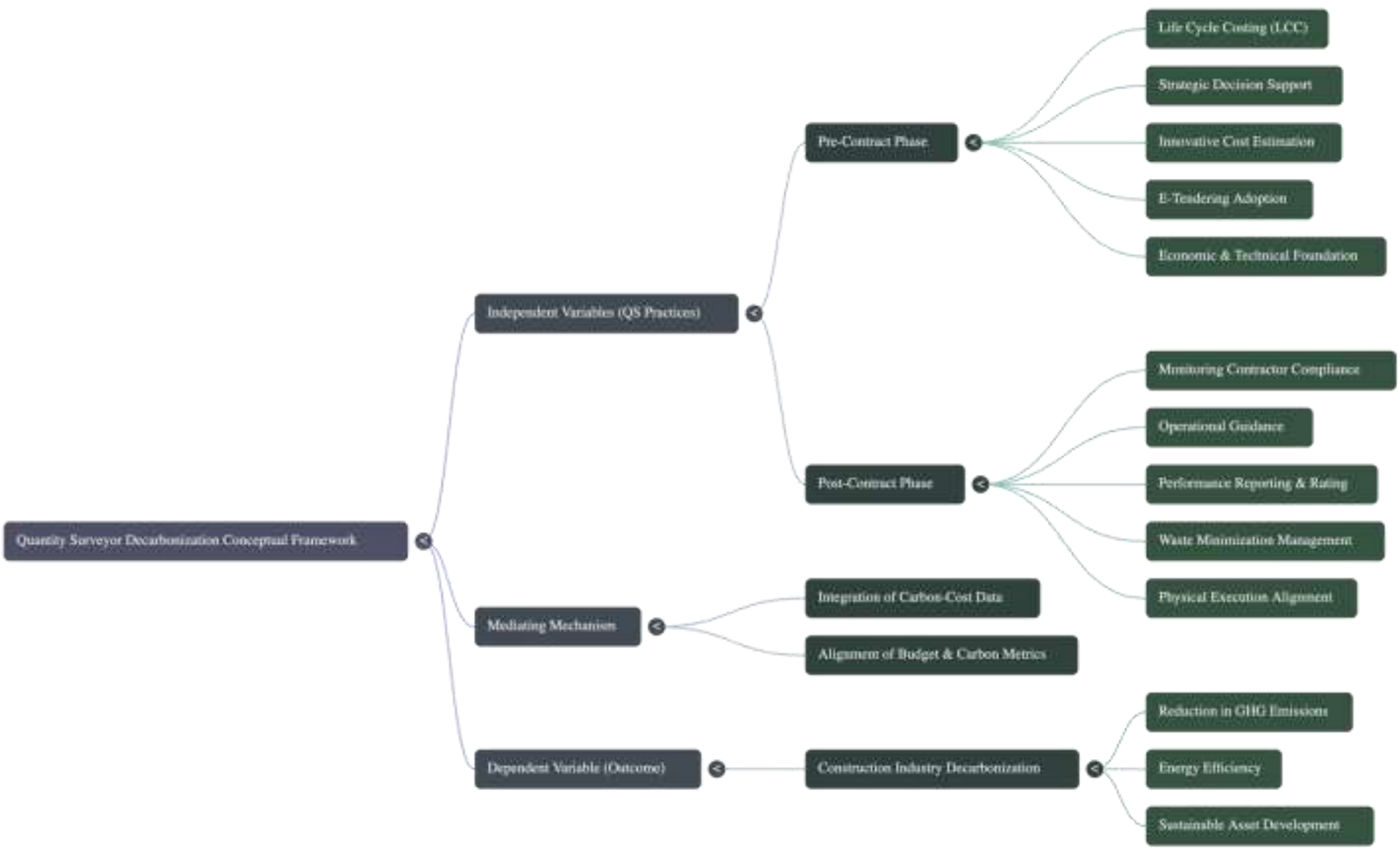
Synthesis of Professional Practice: The Emerging Role of QS in Decarbonization

Synthesizing the pre-contract and post-contract practices discussed above, it becomes evident that the quantity surveyor's role is undergoing a significant transition from a traditional financial estimator to a strategic "carbon manager." While the literature (Olanrewaju & Anahve, 2015; Yun et al., 2023) establishes the theoretical necessity of decarbonization, there is a critical disconnect between high-level sustainability policies and the operational realities of daily measurement practices. The current literature tends to treat cost estimation and carbon management as parallel but siloed functions. This study argues that for successful decarbonization, these must be integrated. The synthesis suggests that without a structured, data-driven approach to carbon-cost reporting, practitioners will continue to face barriers in both economic feasibility and technical compliance, thus necessitating a rethink of standard quantity surveying workflows toward an integrated carbon-cost framework. To conceptualize the dynamics of sustainable construction, Figure 1 illustrates the conceptual framework for this study. The framework establishes that the quantity surveyor's professional contributions are structurally divided into two core operational phases comprises of Pre-Contract and Post-Contract practices which serve as the independent variables. These practices are mediated by the integration of carbon-cost data to achieve construction industry decarbonization outcomes.

Figure 1: Conceptual Framework of Quantity Surveyors' Practices in Decarbonizing the Construction Industry



RESEARCH METHODOLOGY

The research utilized a questionnaire survey method based on quantity surveyors' practices in decarbonizing the construction industry. To measure these factors, a 5-point Likert scale (1 = Strongly Disagree to 5 = Strongly Agree) was utilized to indicate the level of agreement on those indicators representing their main attributes. This study adopted a simple random sampling method, whereby the population of this study comprises quantity

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surveyors from various backgrounds including contractors, consultants, property developers, and government agencies working in Kuching, Sarawak.

In terms of sample size calculation, the optimal sample size was determined using the Raosoft sample size calculator. Based on a total population size of 564 construction enterprises and professionals, the minimum sample size was established at 229 respondents using a 5% margin of error, a 95% confidence level, and a 50% response distribution. The sampling frame focused on quantity surveyors across various organizational backgrounds, as these professionals are directly involved in pre-contract and post-contract cost and procurement processes that decarbonization strategies target.

Hence, questionnaires were distributed to quantity surveyors via online platforms (Google Forms via WhatsApp and email) as well as physical distribution. Out of the targeted sample size, 89 valid responses were completed and returned, representing a response rate of approximately 39%. This figure exceeds the minimum threshold for survey responses in construction-related research, where a response rate between 25% and 35% is generally deemed acceptable for self-administered questionnaires (Fateh & Nijar, 2019; Oladimeji, 2019). Furthermore, although the obtained sample of 89 responses is smaller than the initially calculated target of 229, this 39% response rate remains analytically viable for exploratory descriptive research in this sector. However, this smaller sample size introduces a potential limitation regarding non-response bias, which must be considered when generalizing the findings. The research has adhered to ethical considerations, including informed consent, confidentiality, and data handling. For this study, the outcomes of the research were analyzed using IBM SPSS Version 27 for frequency, percentage, mean, and standard deviation. In addition, the reliability of the instrument was assessed through a pilot study using Cronbach's Alpha, yielding a high score of 0.948, which comfortably exceeds the acceptable threshold of 0.70 to ensure internal consistency. While Cronbach's Alpha demonstrates strong internal consistency, the content validity was established through rigorous alignment with existing literature, paving the way for future construct validation.

RESULTS AND DISCUSSION

The results revealed that Cronbach's Alpha value for the questionnaire items was 0.948, which comfortably exceeds the standard threshold of 0.70, indicating a high level of internal consistency and reliability for the collected data. While this study primarily relies on descriptive statistics to map current perceptions and practices, this fundamental approach is necessary to establish baseline data in regional corridors like Sarawak, setting the stage for future inferential and predictive analyses. Table 1 presents a comprehensive summary of the mean scores, standard deviations, and rankings for all key variables investigated in this study.

Table 1: Summary of Mean, Standard Deviation, and Rankings for Key Variables

Category / Variable Indicator	Mean (M)	Std Dev (SD)	Rank
1. Decarbonization Strategies / Drivers			
Mitigating Climate Change	4.28	0.65	1
Maximizing Market Opportunities	4.10	0.71	2
Reducing Carbon Emissions	4.08	0.69	3
Achieving Long-Term Cost Savings	4.06	0.74	4
2. Key Barriers to Decarbonization			
Limited Training & Knowledge	4.29	0.62	1
Limited Awareness & Lack of Industry Interest	4.28	0.66	2 (Tie)
Lack of Regulations	4.28	0.68	2 (Tie)
Economic Challenges	4.08	0.72	4
Lack of Green Product Suppliers	4.06	0.75	5
3. Pre-Contract QS Practices			
Implementation of E-Tendering Systems	4.22	0.64	1
Updating Cost Estimations (Innovative Techniques)	4.13	0.69	2
Guiding Decision-Making (Client Values)	4.07	0.73	3 (Tie)
Life Cycle Costing (LCC) Assessment	4.07	0.75	3 (Tie)

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4. Post-Contract QS Practices			
Monitoring Contractor Compliance	4.07	0.71	1
Providing Operational Guidance	4.06	0.73	2
Reporting Building Performance / Carbon Footprint	3.97	0.78	3
5. Recommendations for Improvement			
Government Initiatives & Policy Support	4.34	0.59	1
Specialized Training & Education Programs	4.31	0.61	2
Green Technologies (e.g., BIM)	4.27	0.67	3 (Tie)
Digitalization & Green Cloud Computing	4.27	0.68	3 (Tie)
Cross-Industry Collaboration	4.12	0.70	5

Findings: Decarbonization Strategies and Drivers in the Construction Industry

The findings regarding decarbonization strategies demonstrate that respondents strongly recognize the critical role of the construction industry in generating carbon emissions, yielding consistently high mean scores. Specifically, mitigating climate change emerged as the highest-ranked factor with a mean score of 4.28 (SD = 0.65), followed by maximizing market opportunities (Mean = 4.10, SD = 0.71), reducing carbon emissions (Mean = 4.08, SD = 0.69), and achieving long-term cost savings (Mean = 4.06, SD = 0.74). These results align with Arent et al. (2022) and Peng et al. (2022), who emphasize that proactive decarbonization is essential to curb global temperature rises and environmental degradation. The high prioritization of mitigating climate change over purely economic drivers, such as long-term cost savings, indicates a maturing professional mindset among Sarawak's construction practitioners. This paradigm shift aligns with Malaysia's broader national agenda to achieve net-zero emissions by 2050 (Chang, 2022). It suggests that quantity surveyors are increasingly aware of their ethical and professional responsibilities toward environmental stewardship, viewing decarbonization not merely as a cost-compliance issue, but as a critical industry evolution (Yun et al., 2023).

Conversely, the primary challenges hindering decarbonization efforts were identified as limited training (Mean = 4.29, SD = 0.62), followed closely by limited awareness and lack of industry interest (Mean = 4.28, SD = 0.66) and lack of regulations (Mean = 4.28, SD = 0.68), alongside economic challenges (Mean = 4.08, SD = 0.72) and a lack of green product suppliers (Mean = 4.06, SD = 0.75). These barriers corroborate findings by Hidayah Idris et al. (2015) and Arogundade et al. (2023), who noted that insufficient specialized training and financial constraints heavily impede the transition toward low-carbon construction practices.

The emergence of 'Limited Training and Knowledge' as the most formidable barrier highlights a critical capacity gap specifically within regional corridors. Unlike metropolitan hubs such as the Klang Valley, where green building initiatives and professional development programs are more established, practitioners in Kuching may lack consistent access to specialized carbon-accounting workshops and localized green material databases. Furthermore, the equally high ranking of 'Lack of Regulations' underscores a structural vulnerability: without mandatory government policies and standardized frameworks enforcing carbon limits, voluntary decarbonization efforts often face resistance from clients due to perceived high initial capital outlays. This regulatory void directly exacerbates the 'Lack of Industry Interest', indicating that intrinsic motivation alone is insufficient to drive industry-wide transformation without statutory enforcement (Smith, 2018; Tokbolat et al., 2020).

Findings: Quantity Surveyors' Practices in Pre-Contract and Post-Contract Decarbonization

In evaluating quantity surveyors' practices during the pre-contract stage, descriptive analysis indicated that the implementation of E-tendering systems ranked highest with a mean score of 4.22 (SD = 0.64), serving as a primary driver for improving efficiency and transitioning toward a paperless environment to reduce carbon footprints. This was followed by assisting in the updating of cost estimations to incorporate innovative decarbonization techniques and prevent project failures (Mean = 4.13, SD = 0.69), guiding decision-making to align project delivery with client values (Mean = 4.07, SD = 0.73), and conducting life cycle costing (LCC) to assess the environmental impact of materials and construction processes (Mean = 4.07, SD = 0.75). These findings support the assertions of Hashim et al. (2020) and Danjuma (2022), highlighting that pre-contract integration of carbon quantification and digital procurement tools is vital for sustainable project governance.

Meanwhile, during the post-contract stage, monitoring contractor activities to oversee and verify compliance with carbon reduction protocols ranked highest with a mean score of 4.07 (SD = 0.71), closely followed by providing guidance to contractors on process improvements to align with carbon targets (Mean = 4.06, SD = 0.73), and reporting on the overall carbon performance and footprint of buildings (Mean = 3.97, SD = 0.78). These operational findings validate the arguments of Shehu (2023) and Bolade-Oladepo et al. (2020), demonstrating that quantity surveyors must actively oversee site execution, manage embodied carbon, and evaluate sustainable attributes to support green building standards.

Finally, regarding recommendations to enhance quantity surveyors' decarbonization practices, government initiatives ranked highest (Mean = 4.34, SD = 0.59), followed by specialized training and education programs (Mean = 4.31, SD = 0.61), green technologies such as BIM (Mean = 4.27, SD = 0.67), digitalization practices like green cloud computing (Mean = 4.27, SD = 0.68), and cross-industry collaboration (Mean = 4.12, SD = 0.70). These recommendations reinforce the conclusions of Yun et al. (2023) and Lau et al. (2021), proving that a multi-faceted approach involving policy support, digital upskilling, and collaborative partnerships is indispensable for empowering quantity surveyors to drive the future low-carbon construction industry.

CONCLUSION

This study concludes that decarbonization practices have become an essential consideration for quantity surveyors in Kuching, Sarawak, moving beyond optional tasks into core professional responsibilities. Empirical findings indicate that while industry practitioners heavily recognize the importance of mitigating climate change and reducing carbon emissions, their operational efficiency is heavily restricted by structural barriers such as limited training, a lack of awareness, and scarce regulatory frameworks. In response, quantity surveyors actively leverage pre-contract mechanisms such as E-tendering systems and life cycle costing (LCC) alongside post-contract execution measures like monitoring contractor compliance and reporting building carbon footprints. Ultimately, to bridge the gap between high-level sustainability policies and day-to-day cost management, targeted government interventions, continuous professional upskilling, and digital integration are urgently required to empower the surveying profession toward a net-zero future.

Despite the valuable insights provided, this study presents several limitations. Firstly, the data relies heavily on descriptive statistics and measures practitioners' perceptions of operational effectiveness rather than quantifiable, actual carbon reductions. Consequently, future research should employ inferential statistical methods such as Structural Equation Modelling (SEM) or multiple regression to empirically test the relationships between pre- and post-contract practices and specific decarbonization outcomes. Secondly, future studies must incorporate objective environmental indicators, including measurable reductions in embodied carbon, on-site material waste tracking, and energy performance metrics. Ultimately, to transition the quantity surveying profession from a traditional cost-centric role to an integrated carbon-cost discipline, future scholarship should focus on developing a comprehensive QS Carbon Management Competency and Maturity Framework.

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Declaration Of Generative Ai and Ai-Assisted Technologies

The authors acknowledge the use of AI-assisted tools solely for the purpose of language editing, grammar checking, and refining the structural clarity of this manuscript. The authors reviewed, verified, and edited all generated content and assume full responsibility for the accuracy and integrity of the final publication.

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Conflict Of Interest Statement

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Data Availability

The datasets generated and analyzed during the current study are not publicly available to preserve the anonymity and confidentiality of the respondents as per the ethical approval requirements, but are available from the corresponding author on reasonable request.

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