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WELCOME SPEECH FROM THE CHAIRMAN

RISM 17th International Surveying Conference for Undergraduates (ISCU 2025)

بسم الله الرحمن الرحيم السلام

عليكم ورحمة الله وبركاته

Greetings to all,

It is with great pleasure that I welcome you to the 17th RISM International Surveying Conference for Undergraduates (ISCU 2025), themed *"Embracing Construction Revolution 4.0: Transforming Malaysia's Built Environment."* On behalf of the Royal Institution of Surveyors Malaysia (RISM), I also wish to express our sincere appreciation to Universiti Teknologi MARA (UiTM), Perak Campus, for graciously hosting this significant event.

As we navigate the era of the Fourth Industrial Revolution (IR4.0)—or in our context, Construction Revolution 4.0 (CR4.0)—we are witnessing transformative advancements across the global construction sector. Technologies such as Building Information Modelling (BIM), the Internet of Things (IoT), artificial intelligence (AI), robotics, big data analytics, and cloud computing are redefining the way we build, manage, and interact with our built environment. For Malaysia, embracing CR4.0 is a strategic imperative to achieve our socio-economic and environmental goals.

This conference serves as a vital platform to unite surveying undergraduates from various disciplines, fostering critical dialogue on industry challenges, enhancing professional networking, and preparing a new generation of talent for the rapidly evolving construction landscape. It is also an opportunity for employers to engage with and inspire our future professionals.

I would like to extend my heartfelt thanks to all industry speakers, paper presenters, judges, and participants for their time, contributions, and support in making ISCU 2025 a success. I also commend the organising committee for curating a meaningful and dynamic conference experience.

May the knowledge gained, connections formed, and ideas exchanged during this event inspire all participants to lead and innovate in their future endeavours.

Wishing everyone a productive and memorable conference.

Prof. Ts Sr Dr. Adi Irfan Bin Che Ani'
Chairman, Universities' Partnering Committee
RISM Session 2024/2025
May 2025

WELCOME SPEECH FROM CO-CHAIRMAN

RISM 17th International Surveying Conference for Undergraduates (ISCU 2025)

Bismillahirrahmanirrahim.

السلام عليكم ورحمة الله وبركاته and greetings to all.

It is my great pleasure to welcome everyone to the 17th International Surveyor Conference for Undergraduates (ISCU 2025), proudly hosted by Universiti Teknologi MARA (UiTM) Perak Branch in collaboration with the Royal Institution of Surveyors Malaysia (RISM). This event is a meaningful platform for students in the built environment to share ideas, showcase innovations, and build professional networks. We are honoured by your presence and enthusiastic participation, with 135 accepted papers and 78 poster presentations this year.

UiTM Perak, home to the College of Built Environment, has long been a hub for academic excellence in architecture, planning, and surveying. Our commitment remains strong in nurturing competent graduates who meet industry demands and contribute to nation-building.

While you're here, we invite you to experience the heritage and culture of Perak Tengah from the architectural richness of Rumah Kutai to the historical towns of Pasir Salak, Bota, and Kampung Gajah.

To all presenters and winners, congratulations on your achievements. Let your work today be a catalyst for future success and academic growth. We hope this conference will inspire you to explore new ideas, foster collaboration, and make lasting memories.

My deepest thanks to the Royal Institution of Surveyors Malaysia (RISM) and the organising committee for making this event a success.

We hope your experience here will be rewarding and unforgettable.

Thank you. Selamat datang dan selamat berjaya.

Associates Professor Dr. Nur Hisham Ibrahim, *PMP*
Co-Chairman, Universities' Partnering Committee
RISM Session 2024/2025
May 2025

WELCOME SPEECH FROM THE PROJECT DIRECTOR

RISM 17th International Surveying Conference for Undergraduates 2025

Alhamdulillah, all praise to Allah S.W.T. for His guidance and blessings in making the RISM 17th International Surveying Conference for Undergraduates (ISCU) 2025 a reality.

It is with great honour and gratitude that I welcome all participants, guests, academicians, and industry professionals to this prestigious event, proudly organized under the Royal Institution of Surveyors Malaysia (RISM). This 17th edition of ISCU stands as a proud testament to our collective dedication toward academic excellence, professional collaboration, and youth empowerment in the field of surveying.

I extend my heartfelt appreciation to RISM for its unwavering support, to the hardworking ISCU 2025 Organising Committee, and to all 16 partnering universities across Malaysia for their commitment and contributions. Your efforts have shaped this conference into a dynamic platform for knowledge exchange, innovation, and professional growth.

To the academicians and practitioners present, your insights are invaluable in bridging the gap between academic theory and real-world practice. To our undergraduate participants, your passion, curiosity, and commitment are the very foundation of our future. May this conference not only deepen your academic journey but also ignite a spirit of leadership, integrity, and sustainable thinking.

Let this gathering serve as more than an academic milestone. May it foster lifelong networks, inspire transformative ideas, and chart new directions in our shared professional journey.

Wishing everyone a rewarding and inspiring conference experience.

Sr Dr. Nurul Fadzila Zahari
Project Director
RISM 17th ISCU 2025

ASSESSING CONTRACTORS' PRACTICES IN REDUCING EMBODIED CARBON IN CONSTRUCTION PROJECTS

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ABSTRACT

Construction industry (CI) is one of the major contributors to carbon emissions (CE) globally, which have a significant impact on climate change. The majority of studies concentrate on reducing operational carbon (OC) during the design and operational phases, while insufficient emphasis is given to embodied carbon (EC) in the construction phase. Although some studies have investigated contractors' practices for mitigating EC, the identified practices were not comprehensive. A comprehensive list of 14 EC reduction practices has been identified in the literature. However, the extent to which these practices have been implemented in Malaysia's CI is unknown. The research objective of this paper is to i. identify the current practices of contractors in reducing EC in construction projects; ii. examine the challenges faced by contractors in implementing low EC practices and iii. propose strategies to increase the adoption of EC reduction practices. A qualitative research methodology is adopted where large-size contractor firms Grade 6 and 7 in Malaysia are interviewed. The research findings of this paper will provide valuable insights for contractors to adopt EC reduction practices within the CI. This research addresses a pivotal fundamental issue in comprehending how to advance in reducing EC in construction projects. The research findings can be utilised to enhance decision-making for effective governmental policy development in Malaysia.

Keywords: carbon emissions, embodied carbon, contractor, construction industry, Malaysia

I. INTRODUCTION

Global warming is now a critical issue due to greenhouse gas (GHG) emissions, with the CI accounting for 36% of energy consumption and 37% of CO2 energy-related emissions globally (UNEP, 2021). Malaysia contributes a total of 288 million tonnes of CO_2 emissions per year from the burning of fossil fuel and industrial processes and is currently ranked 21st out of all nations with the greatest emissions (Ritchie et al., 2020). Compared to other industries, the CI in Malaysia is responsible for 24% of the CE (Rahim et al., 2023). To address this issue, Malaysia is committed to reduce the CE intensity by 45% by 2030 through several initiatives such as the Twelfth Malaysia Plan and the establishment of green rating tools (Ministry of Economy, n.d.).

There is a significant amount of EC from CI, which is from material production and on-site activities. A study shows that manufacturing of building materials produces 80% to 90% of EC and on-site construction activities account for 6% to 17% of EC (Zhang & Wang, 2016). Although EC is being addressed through the Twelfth Malaysia Plan and the establishment of green rating tools, the practices are fragmented and different. This is supported by other research where most of the studies focus on OC reduction during design, manufacturing, and operational stages instead of the construction stage (Jankovic et al., 2021; Huang et al., 2024). Research conducted by Joseph and Mustaffa (2021) has summarized that education and training, uniform and relevant policies, low-carbon designs and materials, recycling material and waste, equipment and logistic planning, carbon assessment tools, and green construction methods are the 7 key practices to reduce CE in the construction operations. Other research showed different practices in reducing EC, such as those in the existing green rating tools (i.e GBI, MyCREST, Green Real Estate (GreenRE), Green Performance Assessment System (GreenPASS), and Penarafan Hijau Jabatan Kerja Raya (PHJKR)) (Abdullah, 2017). The distinct practices in reducing EC in construction indicate a lack of a holistic approach in assessing low EC practices.

Furthermore, it is unclear to what extent contractors practice reducing EC. There is limited research on understanding the current practices adopted by Malaysian contractors to reduce CE during the construction phase of projects (Masyhur et al., 2024). Research by Rodrigo et al. (2019) has identified 22 EC mitigation strategies from the perspective of engineers, quantity surveyors, architects, manufacturers, and project managers instead of contractors. Another review done by Arogundade et al. (2023) also suggests the potential strategies that can be done by contractors to reduce CE on construction sites. Contractors who act as key players during the construction stage have a significant impact on reducing the EC on construction sites. Hence, the research objectives of this paper are to i. identify the current practices of contractors in reducing EC in construction projects, ii. examine the challenges faced by contractors in implementing low EC practices, and iii. propose strategies to increase the adoption of EC reduction practices.

II. LITERATURE REVIEW

A. Embodied Carbon (EC)

EC are the emissions generated by embodied energy (EE) used which is the energy used in the extraction, production, transportation and installation of materials during construction or renovation of a building, as well as in their disposal at the end of their life (Liang et al., 2023). EC can be categorised into 3 groups, which are initial EC, recurring EC and demolition EC.

B. Practices of Reducing EC in Construction

i) Materials

Sustainable materials such as low-carbon and bio-based building materials can effectively lower the EC. Using geopolymer concrete (GPC) as a low-carbon building material can reduce 56.02% EC than conventional concrete (Setiawan et al., 2023). A case study on an 18-storey building in Sydney revealed that a whole timber structure could lower EC by 13-26% compared to a reinforced concrete structure with a flat plate floor (Robati et al., 2021). Furthermore, utilizing recycled materials such as concrete, aggregates, roof tiles, post-consumer timber, reinforcing steel, and others can reduce EC during the construction stage (Arogundade et al., 2023). A study found that recycled aggregates can release 39.57% less CE than natural aggregates (Bampanis & Vasilatios, 2023). Moreover, reusing construction materials can reduce EC by 6.2% (Kumari et al., 2022). Formwork can be reused 30 times and other materials like windows, glass, and plywood can be reused to construct a temporary structure on site (Arogundade et al., 2023). Lastly, using locally manufactured materials instead of importing goods overseas would significantly lower the EC as the transportation distance decreased. Zhang et al. (2024) discovered that sourcing calcined marine clay and waste glass powder locally within the country can reduce the EC from manufacturing concrete by 20%.

ii) Machinery and Equipment

The energy and fuel consumption of machinery and equipment releases significant EC. Reducing machine and equipment idle time can reduce EC. Research by Luo et al. (2019) found that reducing 50% of idle time of construction equipment in the construction of in-situ piles resulted in a reduction of 2.54% EC. Using biodiesel can also reduce EC as it is a new sustainable fuel generation that might replace fossil fuels or be blended with conventional diesel (Zhu & Fan, 2023). Zhu and Fan (2023) found that using B5 waste cooking oil biodiesel in non-road mobile machinery results in a 3.7% reduction of EC compare to the EC using diesel. Next, electric machinery is now being introduced in CI because they are more efficient and has a smaller environmental impact than the fossil fuel machinery. Joseph and Mustaffa (2021) also suggested that renewable energy such as solar and wind energy should be implemented on construction sites to reduce EC and energy consumption. Research by Wu et al. (2019) compared the EC of 30 construction machines and found that there are 13 electric construction machines release relatively low EC because the power supply to the machines comes from solar and wind energy.

iii) Waste Management

The "Laporan Akhir Kajian Sisa Binaan 2018" by CIDB stated that 271,984 tons of C&D waste were generated in Peninsular Malaysia (Ibrahim et al., 2023). The common C&D wastes are timber, metal, concrete, bricks, plastic material, asphalt, aluminium, glass, paper, and cardboard. Recycling of C&D wastes can result in EC reduction as it can reduce the EC from extraction of raw materials (Wang et al., 2018). A case study on a demolished high rise building found that recycling of aluminum can reduce 45% of EC followed by recycling of steel with 35% of total reduction in EC (Wang et al., 2018).

iv) Construction Method

Modern construction techniques such as IBS and Lean Construction can be applied in building construction to reduce EC as traditional methods often contribute more EC due to the high material wastage and use of unsustainable materials. IBS is an innovative construction technique that involves the off-site production of building components, which are subsequently transported and installed on construction sites. Nadia et al. (2020) compared the EE and EC of IBS with conventional construction methods, and the result shows that IBS can lower 31.94% EC. On the other hand, Lean construction is a popular strategy for maximizing value and reducing waste and losses in construction projects. Osorio-Gómez et al. (2020) discovered that applying Lean principles in the project can lower EC up to 24% compared to conventional projects.

v) Technology

Integrating advanced technology such as BIM in the CI has become a key driver in lowering EC and enhancing sustainability. BIM and its related applications offer chances to promote green building practices such as water consumption management, C&D waste management, lighting analysis, CE tracking, acoustic analysis, and operational energy use optimization (Myint & Shafique, 2024). Abdullah & Safa (2024) use Autodesk Revit and Carbo Life Calc Software to estimate and compare the CE of a single-storey office building with different materials. The study found that using low-EC materials can reduce 58.12% of the EC after changing the high-EC materials with low-EC materials in Revit.

vi) Rating Tool

MyCREST is now mandatory for government spending above RM50 million (Bahaudin et al., 2017). MyCREST aims to guide, encourage, quantify, and thus reduce environmental impact in terms of CE throughout the entire life cycle of a building (CIDB, n.d.). Yaman and Rashid (2021) compare the CE between the conventional materials and sustainable materials suggested in the MyCREST, and the findings show that the green building materials such as 30% of BFS concrete mixture, AAC block, and recycled steel roof truss suggested can significantly lower the EC throughout the construction process.

C. Challenges in Implementing EC Reduction Practices

i) Institutional Barriers

Lack of standard guidelines and policies is one of the institutional barriers that hinders the implementation of EC reduction practices in CI. Study have mentioned that there is a lack of standards in managing C&D wastes (Mohammed et al., 2021). Besides, the lack of enforcement of laws and regulations is another institutional barrier., Although the existence of laws and regulations such as the Energy Policy Act, Clean Air Act, and Environmental Protection Act, EC reduction strategies have not been effectively implemented in Malaysia (Mohamed & Vasudevan, 2021). It is due to a lack of enforcement by appropriate regulatory organizations (Mustaffa et al., 2022). Zaki et al. (2024) found that inadequate enforcement of laws and regulations causes project stakeholders to face challenges in waste management on construction sites.

ii) Organisational Barriers

Using building materials and construction techniques that lower EC typically requires high upfront costs compared to conventional alternatives (Abdullah et al., 2024). The low-emission construction equipment and technology used to generate clean and renewable energy on-site also require additional expenses for the projects. Besides, sustainable materials and green technologies are limited for organisations to invest in. Most of the green building materials are imported from other countries as the choices of green materials from the MyHIJAU directory are lacking (Ismail et al., 2023). Technology used to accumulate low-stream water structures and grey water reusing structures is also imported from other countries (Mohamed & Vasudevan, 2021). Additionally, poor communication between stakeholders such as contractors and suppliers further hinders adoption as suppliers struggle to effectively convey the right product information (Carlander & Thollander, 2023). Lack of commitment of organization to implement EC reduction practices is also one of the organisational barriers. This is due to the employer's lack of incentives to encourage employees to pursue lifelong learning and develop the skills needed to use new tools, technologies, materials, and methods (Franzini et al., 2018).

iii) Individual Barriers

Most of the adoption level of EC reduction practices in Malaysia remains low due to the lack of awareness among the stakeholders in green practices (Masyhur et al., 2024). Besides, most practitioners lack training and education that equip them with knowledge and skills to adopt the low EC practices in the projects (Ayarkwa et al., 2022). Zaki et al. (2024) found that a lack of proper training on waste segregation and recycling practices causes workers to hamper effective waste management on construction sites. Since net-zero carbon construction practices are still relatively new, there might be a shortage of professionals and experts who are skilled and knowledgeable in this field (Abdullah et al., 2024). Rahim et al. (2023) found that the implementation of the Internet of Things (IoT) in the CI Malaysia is still low due to a lack of professionals in utilising these technologies. Lastly, resistance to change is a well-known barrier that makes the implementation of EC reduction practices more difficult within a company or project. Carlander and Thollander (2023) discovered that most construction stakeholders fear trying new technology as using the existing technology is more convenient and cost-saving.

C. Strategies to Improve Adoption of Low EC Practices

i) Eduction and Training

Education and training of new sustainable building technologies and techniques supported by the government can raise the awareness of construction stakeholders towards EC reduction practices (Abdullah et al., 2024). Courses, workshops, training programs, and seminars should be conducted for the construction stakeholders to increase their awareness regarding the negative effects of high levels of pollution and CE (Masyhur et al., 2024). The construction stakeholders will become interested in monitoring their construction emissions if the environmental issues, emissions management strategies, and green technologies are properly educated and promoted through the education and training programs (Mustaffa et al., 2022).

ii) Proper Project Planning and Management

Integrating emissions targets into task, operational, and activity planning will guide an organisation towards an effective emissions monitoring process (Mustaffa et al., 2022). Green supply chain management (GSCM) can be adopted in project management to manage CE. GSCM includes waste management, green packaging, assessing suppliers' green performance, lowering EC during product delivery, and manufacturing eco-friendly products (Abdul Rashid & Muhmad, 2024). Besides, sustainable site management can also be implemented to manage wastes, materials, resources, and equipment that would emit CO_2 (Mustaffa et al., 2022).

iii) Government Incentives

As the implementation of low-EC practices requires higher costs, Masyhur et al. (2024) found that the incentives from the government are the most important strategies to promote the adoption of green practices. The government must support these practices through the implementation of beneficial programs and incentives such as tax refunds, capital subsidies, and loan incentives to motivate construction firms to use green technology and adopt emissions measures in their project (Mustaffa et al., 2022). The Green Technology Tax Incentive and Green Technology Funding Scheme are examples of tax incentives and funding schemes established by the government to financially support organisations that practice low-carbon strategies.

iv) Enhancement of Policies and Regulations

The governments should enact specific environmental acts or regulations that emphasise the lowering of EC in the CI to reduce EC effectively (Abdullah et al., 2024). From the 38 articles, Masyhur et al. (2024) discovered that enforcing policies and regulations is the third most significant strategy to improve the adoption of carbon reduction practices. Stricter laws and regulations pressure organisations to adopt carbon reduction practices as they will be penalised if they do not follow the mandatory requirements for their construction projects (Mohamed & Vasudevan, 2021). EC contributed by contractors and project owners should be monitored, and if CE exceeds the predetermined level, penalties should be imposed (Abdullah et al., 2024).

iii) METHODOLOGY

A. Research Design

The flowchart of research framework is illustrated in Figure 1.0.

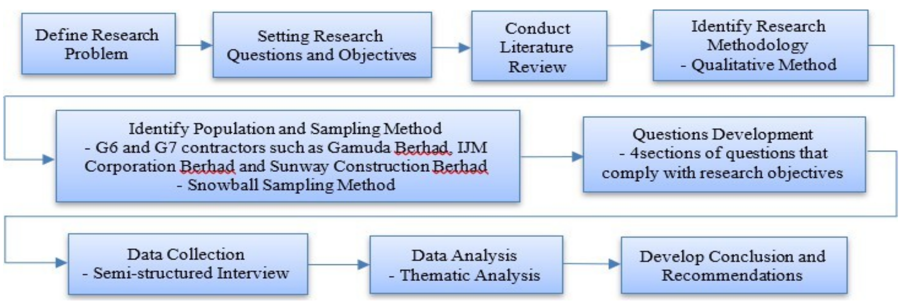

Figure 1.0 Research Framework

B. Research Approach

This research adopts qualitative research method, where data is collected through interviews. Qualitative method is used because this study aims to identify the current EC reduction practices, challenges faced by contractors and their suggestions to increase the adoption of low EC practices. Even though the low EC practices can be identified through literature review, not all of the contractors in the Malaysian CI implement the practices in their construction projects. Qualitative methodology is more suitable for capturing more detailed information than the quantitative methods might overlook. More information and new ideas might be discovered during the interview section with the targeted respondents which can provide new insights to this study.

C. Research Population and Sample

In this research, the population is the G6 and G7 contractors active in the Malaysian CI and have implemented EC reduction practices in their construction projects. A non-probability sampling of snowball sampling method is used. Snowball sampling method begins with one respondent and continues based on the respondent's recommendations until it reaches the desired sample or saturation point. Due to most of the studies have found that the adoption level of EC reduction practices in the Malaysian CI is still low, the population is hard to reach, and the sample is difficult to determine. It is better first to reach out to a contractor with knowledge of this study and adopt low EC practices and seek referral of another contractor with the same criteria from that contractor to avoid wasting of time. Due to the time constraint, this study has been set to a minimum of 3 respondents.

D. Development of Questions

A set of questions have to be developed to give an overview on the process of the interview. The questions are divided into 4 sections, which are:

1) <u>Section A – Respondent's Demographic Information</u>
   The respondents will be asked to give some information about himself/herself such as name, position, company name and year of working experience in the contractor firm.
2) <u>Section B – Current Practices in Reducing EC</u>
   The respondents will be asked to provide the current EC reduction practices adopted by their companies.
3) <u>Section C – Challenges Faced in Implementing Low EC Practices</u>
   The challenges encountered by the respondents when implementing EC reduction practices will be asked in this section.
4) <u>Section D – Strategies on Increasing Adoption of EC Reduction Practices</u>
   This section seeks suggestions on how to enhance the adoption of EC reduction practices in the industry.

E. Data Collection

Data is collected through semi-structured interviews. The targeted respondents in the interview are G6 and G7 contractors registered under CIDB who actively adopt carbon reduction practices in their construction projects. The interview is conducted either online or face-to-face with the respondents. Google Meet or Microsoft Teams will be used to conduct the online interview, while the respondent's offices will be the place to conduct the face-to-face interview. The duration of the interview is pre-set at 30 minutes or 1 hour for each respondent, depending on the sharing of the respondents. With the permission of the interviewee, each interview session will be recorded and then transcribed for data analysis.

F. Data Analysis

Thematic analysis is adopted to analyse the data. Firstly, the data obtained is compiled by transcribing the interview conversation. The data is sorted once the text has been transcribed according to the required data that has been predetermined to meet the interview's objectives. After the data are properly sorted, codes will be created based on the sorted data. The codes help to categorise and interpret the data in a structured manner. Next, the codes are grouped into several relevant themes. In this step, the codes that are unclear or irrelevant to the theme will be eliminated. After reviewing the theme, each theme is defined and named. Finally, the analysed data can be shown in tables, hierarchy charts, or other graphical forms for discussion.

CONCLUSION

Ultimately, the findings of this study can serve as a foundation for policymakers, industry practitioners, and stakeholders to implement more effective strategies for reducing EC. By understanding current practices and challenges faced by contractors, targeted solutions can be developed to promote greater adoption of low-EC initiatives. These insights will also strengthen sustainability efforts and guide future policy development within Malaysia's CI.

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