

KDN PP 11720/4/2013 (032270)



LEMBAGA JURUTERA MALAYSIA
BOARD OF ENGINEERS MALAYSIA

THE
VOL.104
OCTOBER-DECEMBER 2025

INGENIEUR

MAGAZINE OF THE BOARD OF ENGINEERS MALAYSIA

Construction Industry





A member of UEM

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At PLUS, with a dedicated team of 3,800 personnel, we are committed to providing world-class facilities and services that prioritise the safety and comfort of our highway users. PLUS offers a dynamic platform for our engineers to develop their expertise, advance their careers, and shape the future of highway management through innovative solutions and cutting-edge practices.

Ir. Ts. Noordini Harliyati Ramli
(PE P117506)
Traffic Safety

Every individual, regardless of gender, possesses a distinctive spark that drives innovation in engineering. Your unique perspective is not merely valuable, it is crucial for the advancement and transformation of our industry. A diversity of thought stimulates creativity and propels progress, enabling us to develop effective solutions for the challenges we encounter.

Ir. Maizatul Zaila Kamarol Zaman
(PEPC C110553)
Strategic Planning
and Development

I am honored to be part of the backbone that supports Malaysia's transportation infrastructure. My 30 years at PLUS have not only enriched my engineering expertise but also allowed me to contribute to enhancing the efficiency and safety of our nation's mobility network.

Ir. Ts. Adam Junid
(PEPC C113254)
Mechanical, Electrical and Electronic

Engineers carry a vital responsibility and commitment to public safety throughout design, construction, testing, installation, operations, maintenance and decommissioning phases. Beyond this fundamental duty, our team embodies MyPLUS Culture Practices of 'I Constantly Learn, I Collaborate, I Am Accountable, I Build Trust, I Care, and I Embrace Change'. These MyPLUS Culture Practices support professional growth, preparing them for long-term success in their careers.

EUR ING Ir. Ts.
Azizul Faiz Abdul Aziz
(PE P123178)
Maintenance and
Asset management

PLUS promotes the value of constantly learning with great appreciation for those who are willing to put their best efforts in gaining knowledge. I have obtained my Professional Technologist, my Chartered Professional Civil Engineer, my Professional Engineer and most recently the accreditation as Professional European Engineer from Engineers Europe Engineering Council. The accreditation received would be crucial in promoting the drive for PLUS in being the best in Highway and Transportation Asset Management within a fast-moving Malaysia's transportation infrastructure industry.

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DESIGN AND PRODUCTION

Dimension Publishing Sdn Bhd

PRINTER

Sky Press Sdn Bhd

No.15, Jalan PBS 14/3,

Taman Perindustrian Bukit Serdang,

43300 Seri Kembangan, Selangor.

The Ingenieur is published quarterly by the Board of Engineers Malaysia (Lembaga Jurutera Malaysia) and is distributed free to registered Professional Engineers. The statements and opinions expressed in this publication are those of the writers. BEM invites all engineers and readers to contribute relevant articles and views to the Publisher.

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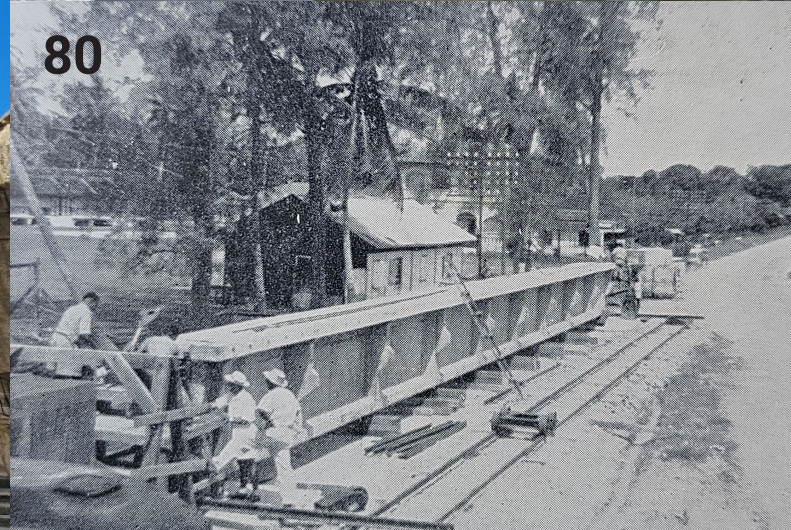
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CALL FOR ARTICLES

The Ingenieur is published quarterly by the Board of Engineers Malaysia. The following are the themes for the coming issues.

Vol. 105 Jan-Mar 2026

Engineering Practice

Vol. 106 Apr-Jun 2026

Engineering the Energy Transition

Vol. 107 Jul-Sept 2026

Engineering Physical Connectivity

Articles and other contributions relevant to the themes are welcomed, but the decision to publish rests with the Editorial Board.

Advertising inquiries are also welcomed. Please refer to the BEM advertisement on Page 30 for the latest rate card and booking form.

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Construction Industry



Datuk Wira Ir. Roslan bin Ismail
President
Board of Engineers Malaysia

The construction industry continues to play a central role in Malaysia's economic development, contributing substantially to our national GDP and providing the foundation for growth across multiple sectors. As stewards of this critical industry, professional engineers bear the responsibility and accountability of ensuring that construction works are executed with the highest standards of safety, integrity and professionalism.

In today's evolving landscape, engineers must also respond to broader imperatives. The integration of Environmental, Social and Governance (ESG) considerations into project planning and execution is no longer optional, but essential. Sustainable design, efficient resource use, and inclusive development are benchmarks that define progressive nations.

At the same time, the preservation of our architectural heritage must remain a shared commitment, linking modern development with cultural continuity.

The Board of Engineers Malaysia (BEM), through its strategic plan, envisions our engineers taking their rightful place in the global value chain. Our expertise and adaptability enable us to contribute, not only within national borders but also on international platforms, strengthening our nation's reputation for engineering excellence.

BEM remains dedicated to advancing professional standards, enhancing competency, and encouraging global engagement. Let's reaffirm our role as trusted professionals and ensure the construction industry continues to deliver lasting value to the nation and beyond. 🏗️

BEM Engineering Awards 2025: Celebrating Excellence and Leadership in Engineering



The arrival of YAB Dato' Sri Haji Fadillah Haji Yusof, Deputy Prime Minister and Minister of Energy Transition & Water Transformation (PETRA)



YAB Deputy Prime Minister delivering his speech



The guests waving Jalur Gemilang



Gamelan performance by engineering students from Universiti Teknologi PETRONAS (UTP)

The Board of Engineers Malaysia (BEM) reaffirmed its commitment to recognising engineering excellence and leadership at the BEM Awards & Appreciation Dinner 2025, held to honour individuals and organisations that have made significant contributions to the profession.

The event, graced by YAB Dato' Sri Haji Fadillah Haji Yusof, Deputy Prime Minister and Minister of Energy Transition & Water Transformation (PETRA), was attended by industry leaders, professional engineers, representatives from academia and the public.

With over 220,000 registered persons forming the engineering team, the engineering community serves as a critical pillar in the country's development. The BEM Engineering Awards serve as an important platform for recognising professional achievement, upholding integrity and promoting excellence across the profession.

Honouring National Engineering Icons

The 2025 awards highlighted outstanding achievements in three main categories, recognising individuals who had demonstrated leadership, innovation and service to the nation.

Anugerah Tokoh Kejuruteraan Negara 2025 (National Engineering Icon Award 2025)

The prestigious Anugerah Tokoh Kejuruteraan Negara 2025 award was presented to YBhg. Dato' Seri Ir. Dr. Zaini Ujang, a Professional Engineer with Practising Certificate registered with BEM. An expert in water management and environmental sustainability, Dato' Seri Ir. Dr. Zaini has held several senior government positions and was the youngest person to be appointed

Vice-Chancellor of Universiti Teknologi Malaysia (UTM). His distinguished service also earned him international recognition, including the Merdeka Award and Japan's Order of the Rising Sun Award. He received a commemorative gold coin and certificate plaque in recognition of his long-standing contributions to the engineering profession.

Anugerah Tokoh Muda Kejuruteraan Negara 2025 (National Young Engineering Icon Award 2025)



Ir. Alex Looi Tink Huey receiving the Tokoh Muda Kejuruteraan Negara Award 2025



Dato' Sri Ir. Dr. Zaini bin Ujang receiving the Tokoh Kejuruteraan Negara Award 2025

The Anugerah Tokoh Muda Kejuruteraan Negara category recognises young engineers under the age of 40 who have shown exceptional promise and leadership in the early years of their careers.

This year, the award was conferred upon Ir. Alex Looi Tink Huey, a Professional Engineer and ASEAN Chartered Professional Engineer, for his work in electrical engineering and digital transformation. His notable achievements include leading the development of Malaysia's largest palm oil mill effluent (POME) biogas plant, contributing to sustainable and renewable energy efforts. He was presented with a commemorative gold coin and certificate plaque.

Special Mention International Engineering Award (SMIEA) 2025

Introduced to acknowledge Malaysian engineers who have been recognised internationally, this inaugural Special Mention International Engineering Award celebrates BEM-registered engineers who have received prestigious awards from global professional bodies. Two engineers were honoured in this category and received certificate plaques.

1. Professor Ir. Dr. Mohd Sapuan Salit, recipient of The World Academy of Sciences (TWAS) Award 2024 for his contributions to the development of tropical natural fibre composite materials.



Special Mention International Engineering Excellence Award's recipient, Professor Ir. Dr. Mohd Sapuan Salit

2. Professor Ir. Dr. Syuhaida Ismail, Acting Director General of the Maritime Institute of Malaysia, recipient of the WFEO-GREE Women in Engineering Award 2024 from the World Federation of Engineering Organizations (WFEO) for her contributions to advancing women's leadership in engineering.



Professor Ir. Dr. Syuhaida Ismail receiving the Special Mention International Engineering Excellence Award

Acknowledging Partners & Collaborators

BEM also extended its appreciation to 13 engineering societies for their support and continuous contribution to the advancement of the engineering profession. These were:

1. Association of Consulting Engineers Malaysia (ACEM).
2. Construction Inspector of Works Association Malaysia (COWAM).
3. Federation of Manufacturing Malaysia (FMM).
4. Malaysia Engineering Inspector & Supervisor Association (MEInSA).
5. Malaysia Oil & Gas Engineering Council (MOGEC).
6. Malaysia Society of Medical & Biological Engineering (MSMBE).
7. Malaysian Association of Engineers (MAE).
8. Malaysian Society for Engineering & Technology (MYSET).
9. Malaysian Stormwater Organisation (MSO).
10. Malaysian Water Association (MWA).
11. Persatuan Jurutera Profesional Pengangkutan Jalan Malaysia.
12. Technological Association Malaysia (TAM).
13. The Institution of Engineers Malaysia (IEM).

In addition, 8 media partners were recognised for their contribution to public awareness through responsible reporting and continuous support in promoting engineering initiatives and public safety. Each organisation received a certificate plaque presented by the Deputy Prime Minister. These were:

1. Berita Harian.
2. New Straits Times Press (NSTP).
3. Pertubuhan Berita Nasional Malaysia (BERNAMA).
4. Radio Televisyen Malaysia (RTM).
5. The STAR (Star Media Group).
6. TV3.
7. TV ALHIJRAH.
8. Utusan Malaysia.



Special Appreciation to allied engineering associations



Special Appreciation to BEM's media partners

Engineering as a Driver of National Progress

The BEM Engineering Awards 2025 reinforced the narrative that the engineering profession is a core driver of national development. By celebrating

these leaders and innovators, the awards highlight the profession's role in driving change, shaping policy and supporting innovation and technological advancement, reflecting Malaysia's aspiration to emerge as a progressive and competitive regional engineering hub on the global stage. 🌐

BEM National Engineering Convention (NEC) 2025: Engineering Malaysia, Integrating ASEAN



The Malaysia Engineering Landmarks Book being launched by YB Dato Sri Alexander Nanta Linggi, Minister of Works, witnessed by Datuk Wira Ir. Roslan bin Ismail, BEM's President

The Board of Engineers Malaysia (BEM) continued its commitment to strengthen the nation's engineering community through its annual flagship programmes: The National Engineering Convention (NEC) 2025 in Kuala Lumpur and the BEM Roadshow & Open Day 2025 in Sabah and Sarawak.

Formerly known as the BEM Convention, this year's renamed National Engineering Convention marked a renewed effort to promote professional development, knowledge sharing and collaboration among engineers, policymakers, educators, and students in Malaysia and the ASEAN region.

Engineering Malaysia, Integrating ASEAN

The National Engineering Convention (NEC) 2025, held from 19 to 22 August 2025 at the

Connexion Conference & Event Centre in Bangsar South, Kuala Lumpur, carried the theme Engineering Malaysia, Integrating ASEAN.

Officiated by YB Dato Sri Alexander Nanta Linggi, Minister of Works, the convention drew nearly 1,000 participants, including professional engineers, industry leaders, academicians, government representatives and students from Institution of Higher Learning. The event served as a dynamic platform for thought leadership and regional collaboration, aligning our engineering aspirations with ASEAN's collective progress.

At the Opening Ceremony, Dato Sri Alexander Nanta Linggi launched a commemorative book, Malaysia Engineering Landmarks, which showcased the nation's most iconic engineering achievements and heritage.



PERODUA newly registered Professional Engineers (PE) showing their PE Certificate

One of the major highlights of NEC 2025 was the Professional Engineer (PE) Conferment Ceremony, which honoured newly conferred Professional Engineers. They received a limited-edition BEM collar pin and a hardcopy certificate as a symbol of professional recognition and achievement.

Another key highlight was the signing of Memorandums of Agreement (MoA) with Universiti Malaysia Perlis (UniMAP) and Universiti Malaysia Terengganu (UMT). Through these collaborations, BEM continues the Leadership & Management Programme on Entrepreneurship, a Continuing Professional Development (CPD Category 1) initiative tailored for consulting engineers with PEPC certification.

The NEC 2025 offered a rich and engaging programme, from policy and regulatory updates to technical workshops and recognition events that celebrated engineering excellence.

Among the main sessions were the Forum on Business Opportunities & Challenges, where representatives from Malaysia, Kenya, Saudi Arabia, Thailand, and Pakistan shared insights on cross-border collaboration, and the Forum on ASEAN Chartered Professional Engineers, which discussed mutual recognition and mobility within the region. The keynote address, titled Engineering Malaysia, Integrating ASEAN, was delivered by YBhg. Dato' Paduka Ir. (Dr.) Keizrul Abdullah, Tokoh Kejuruteraan Negara 2024.

Hands-on learning also took centre stage through Workshops on Outcome-Based PAE (Examiners) and Construction Design Management (CDM): CDM Professional Trained Person, both of which received strong participation from industry practitioners.



MOA between BEM and UMT



Forum Panellist on Engineering Leadership



Sharing Session by experts from BEM.
 From left: Dato' Paduka Ir. (Dr) Hj. Keizrul bin Abdullah (Tokoh Kejuruteraan Negara 2024), Ir. Hamzah bin Hashim (BEM Secretary), Ir. Sharifah Azlina binti Raja Kamal Pasmah (Member, BEM National Monitoring Committee/ CEO HSS Engineering Sdn Bhd) and Datuk Ir. Mohd Adnan bin Mohd Nor (Member, National Monitoring Committee/Chairman, RPM Engineers Sdn Bhd)

To nurture future talents, the Future Engineering Talents Gateway provided a platform for students and young engineers to connect with mentors and industry leaders through hackathons, career talks, and academic guidance sessions.



SMK Perempuan Likas, one of the participating schools in BEM's STEM Competition in Sabah, is hard at work building a strong and resilient structure



SMK Siburan, the winner of the BEM STEM Competition in Sarawak, receiving their prizes

Expanding Regional Impact: BEM Roadshow & Open Day 2025 in Sabah and Sarawak

Building on the momentum of the National Engineering Convention, BEM extended its outreach with the BEM Roadshow & Open Day 2025 in Sabah and Sarawak. These annual regional programmes continue BEM's commitment to strengthening professional development, enhancing regulatory awareness, and inspiring greater participation in engineering through interactive STEM and innovation-driven activities.

Each edition featured two days of concurrent sessions that brought together professionals, educators, and students. While industry participants engaged in seminars and technical workshops focused on current engineering practices and policies, the Open Day created an energetic learning environment for younger audiences.

For secondary school students, the road show introduced hands-on STEM competitions and knowledge-sharing sessions designed to ignite early curiosity in science, technology, and engineering. Meanwhile, students from institutions of higher learning participated in mentor-mentee programmes, Final Year Project showcases, and hackathon challenges. All were aimed at inspiring future engineers, promoting awareness of BEM registration, strengthening innovation and problem-solving skills, and fostering valuable mentorship and networking within the engineering community. 🏆



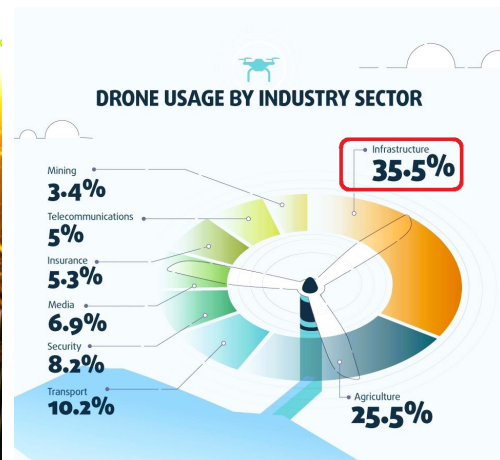
Congratulations to Institut Kemahiran MARA (IKM) Bintulu, the Winner of the Final Year Project Competition under the National Undergraduate Engineering Talent (NUET), BEM

Smart Drone Solutions Towards World Class Construction

by
Dato' Prof. Ir. Dr. Eric
KH Goh¹,
Lim Guang Ming²,
Dato' Ir. Fong Tian Yong¹

¹Board of Engineers Malaysia

²Drone Academy Asia



Source: modified from hillmannconsultancy.com

As we reflect on the monumental infrastructure achievements that have shaped Malaysia's skyline, from the soaring heights of Merdeka 118 and PETRONAS Twin Towers to the forward-looking North-South Expressway and Pan Borneo Highway transport networks, one fact is crystal clear: The ever-dynamic engineering profession has always been and still remains the steadfast establishment upon which national development progress is strategised.

Worldwide, the landmark construction industry is recognised as the key contributor for any nation striving for a systematic infrastructure development and attaining a Developed Nation status. Certified engineering professionals

and the construction industry are thus globally acknowledged as catalysts for responsible design and eventual construction of iconic buildings, infrastructures and amenities, all with the prime objective of strategic society enrichment.

Owing to the rapid and vibrant advances of digital transformations around the world, the global engineering fraternity and the respective construction industries are experiencing an increasing demand for drone solutions in project problem solving. Global industrial surveys have noted that the infrastructure/construction industry is the most innovative and accounts for an impressive 35.5% of all commercial drones used.

Some benefits for the use of drones at the construction sites include faster results, increased task precision and more confident project decision-making, complemented with the positive outcome of enhanced workflow efficiency. Comprehensive site surveys, accurate data compilations and rapid information analysis, via the application of drones in daily project tasks, help in real-time monitoring of construction job progress. Other advantages include constructive means to improve work productivity, responsible implementation of efficient site environmental social governance and adherence to occupational safety standards.

Thanks to the recent leap in digital technological progress, commercial drones have emerged as invaluable and necessary tools for the construction industry to evolve towards world class engineering success. Key benefits include options for improvements in remote data collection, enhancement in project management and productivity, leading to an upsurge in company profits... a win-win situation for all.

Legal Regulations for Usage of Commercial Drones - Malaysia



Source: modified from *hillmannconsultancy.com*

For the safety of neighbouring communities, nearby infrastructures and the aviation industry, the use of commercial drones is

bound by legal regulations which need to be strictly adhered to. The commercial drone usage regulations have been set up by these relevant regulatory agencies of Malaysia: Civil Aviation Authority of Malaysia (CAAM), Malaysian Communications and Multimedia Commission (MCMC), Department of Survey & Mapping Malaysia (JUPEM) and Standard & Industrial Research Institute of Malaysia (SIRIM). Highlights of key legal regulations to be noted for the appropriate usage of drones for flights and projects in Malaysia include:

- Need to obtain the approval of regulatory authorities before start of any project.
- Drones must only operate less than 122m (400ft) above ground level.
- Drones not allowed to fly closer than 30m to people, buildings and vehicles.
- Drones not permitted to fly into restricted/prohibited/security areas.
- Special permission needed to operate within 5km of airports/helipads.
- Drone communication must use only approved set of radio frequencies.
- Airspace Management Classification for drones must be strictly adhered to.
- Permit required for any Drone Aerial Project for photography.
- Designated Drone No-fly Zones must be stringently observed.

Overall, there is great concern worldwide on industrial safety, site security, individual protection against potential accidents from drone collisions and privacy expectations in the responsible usage of drones. A harsh penalty is instituted to encourage accountable safe flight of drones with heavy fines of up to RM50,000 and/or maximum imprisonment of 3 years for any negligent individual drone operator not adhering to the established regulations. The fine is, however, increased to RM100,000 if the task is carried out under the directive of a body corporate or company.



Source: modified from novedge.com

Technological Advancements in Drone Equipment Design

The latest trends in novel yet reliable technology such as drones will benefit any resourceful engineering team since these can help improve efficiency and optimise the construction costs of operations as well as enhance occupational safety and environmental aspects at the worksite. Drones are, basically, flying robots which are controlled remotely by an operator or can even fly autonomously through specially programmed software-controlled flight plans. The accuracy of the assortment of market drone designs in effectively carrying out the various tasks depends on the quality of their embedded software, Global Positioning Systems (GPS) and on-board sensor systems.

Another benefit of using drones in construction site monitoring, progressive work progress assessment, environmental site evaluation, business drone-based photography and information collection, is their ability to gather data in inaccessible/high risk sites or even areas which are deemed unsafe or unstable. An international statistical assessment study noted that the global demand market for commercial drone hardware,

software design and drone usage consultancy is expected to increase at an exponential rate worldwide. The main technological components of a commercial smart drone include:

- Global Positioning System (GPS).
- Gyro Stabilisation, Inertial Measurement Unit and Flight Controllers.
- Drone Motor and Propeller Design.
- Onscreen Real-Time Flight Parameters.
- Internal Compass and Failsafe Function System.
- First-Person View (FLV) Live Video Transmission.
- Intelligent Flight Programmable Systems.
- No Fly Zone Drone Technology.
- Obstacle Detection and Collision Avoidance.

Significance of Drone Flight Safety Management

Drone Flight Safety Management is an important criterion for problem-free project flights during the various phases of infrastructure construction. Some major causes of drone accidents/crashes during flight include operator/pilot error, skipping of pre-flight check-list protocols, drone operated during flight not in line of sight of operator,

automatic flight mode engaged without prior checkout of the area terrain under investigation and potential issues such as low battery, excessive wind strength and signal interference during the time of autonomous flight execution.

The determination of the pre-flight risk assessment level is essential to ascertain whether it is safe to operate the drone on the day of the task/project. Supplementary in-depth technological knowledge expected for the drone pilot/operator for safe flight are Drone Emergency Protocols which need to be quickly implemented in cases of sudden loss of drone control or if the drone battery unexpectedly catches fire during flight.

Probable causes of mid-air accidents include unexpected change in wind strength, presence of a large flock of birds, strong electromagnetic interference in certain areas of the mission flight path and if the drone operator is suddenly incapacitated and so is unable to continue monitoring/controlling the drone during flight. Other Drone Emergency Protocols which need to be put into action immediately are when the public or unauthorised personnel unknowingly strays into the mission flight area and when a drone crashes due to unforeseen reasons.

Benefits of Using Drones for Efficient Construction Site Management



Source: modified from zenadrone.com

The prime emphasis for construction business success is on worksite operation optimisation, occupational safety risk minimisation, monitoring

of site work progress and ESG environmental inspections. With respect to occupational safety issues, the use of drone technology can greatly lower the risks involved by minimising the time the work personnel spends in high-risk accident-prone zones, unstable ground sites or even environmentally-sensitive/chemically hazardous areas.

Drone-based data collection can also boost productivity as survey projects which used to take weeks can now be completed in a few hours. Another advantage in using drones to collect large amounts of site data is that since it is carried out in the air, a lot of time is saved in not having to overcome challenging topographical surface terrain during the initial infrastructure planning and design phase. A high-resolution drone photo can quickly verify any site information required, thus minimising the risk of inaccurate reporting for the area-of-interest. A large economic savings in this data monitoring and collection phase is possible since fewer hours are now required to collect large yet accurate data sets for rapid analysis and confident decision-making by top management. A drone solution study carried out in the industry reported that some operators commented that a single imaging drone can pay for itself in a few months. The financial savings is derived from the benefits of quick management decision-making, overall time savings in data collection, and fast continuously updated information analysis based on real-time monitoring setups. Accurate drone information outputs often help in rapid and optimum decision-making by the respective Government authorities and corporate management teams. The key operational and economic benefits for the use of drones in construction planning, design and daily site work progress include:

- Over 99% accuracy in results.
- Time to complete task is more than 85% faster.
- Cost option of over 5 times cheaper for overall project implementation.

	Construction Industry Phases of Work	AI-Drone Approach	AI-Drone tech. vs Traditional Practices	Operational and % Cost Savings Benefits
1.	Construction Site Topographic Mapping: High-resolution Photogrammetry + 3D Reality Capture	Rapid, cm-level accuracy, 2D/3D site models using RTK/PPK positioning, LiDAR precise topography & cross-sectional map presentation outputs... converts images into georef. Orthomosaics.	Replaces labour-intensive ground surveys and manned aerial flights; faster image capture, safer & higher accuracy.	Survey costs ↓ 30-60%. Time ↓ 30-80%. (1-day project vs days/weeks).
2.	Infrastructure Planning & Design: Digital Twin + multi-sensor fusion (Drone data → planning & design)	Integrate drone photogrammetry/LiDAR/inspection images into a Digital Twin for infrastructure project planning, design and schedule flow modelling.	Better site Planning & Design, fewer reworks, improved project scheduling and more accurate work prediction.	Gains in Operational Efficiency: 5-25% ↑ (depending on site conditions).
3.	Slope Stability/ Soil Erosion Monitoring: AI Image Analytics for site inspections	Computer vision models that can identify cracks, sloughing, seepage, rate of soil erosion and other geotechnical anomalies @ site from drone imagery.	Safer (no need for personnel at hazardous sites), faster identification of hazards, earlier remediation.	40-70% ↓ inspection labour & hazard downtime risks and fewer safety issues.
4.	OSH Monitoring: Real-time telemetry + Edge AI + Safety Analytics for live Worksite Alerts	AI Edge models incorporated in drones to detect imminent hazards... Computer vision flags missing helmets/vests ...Rapid Alerts.	Incident prevention, Faster response time helps prevent worksite stoppages and improves safety.	Substantial Reduction ↓ : Accident mitigation costs and unplanned project downtime.
5.	BIM integration (BIM + schedule) using real-time drone data	Aligns periodic reality drone image capture to planned schedule via progress tracking and delay forensics.	Faster achievement of objective, confident progress, fewer site visual inspections and steadfast approvals.	Schedule compression, earlier detection. Benefits: ≥10% ↓ cost/ time savings.
6.	Predictive Equipment Health & Maintenance	AI-powered Drones inspect and predict equipment health of construction equipment @ respective construction site.	Reduces excessive scheduled downtime and emergency repairs, safer inspections for equipment operating.	10-30% ↓ maintenance costs and downtime events (varies according to site conditions).
7.	AI Defect/Crack Detection for concrete, steel and other important components	Smartly detects/quantifies cracks, spalls, corrosion, moisture for roof inspections, post-storm assessment and for QA/QC, prioritises repairs.	Faster and safer fault detection, more area coverage per hour.	Inspections completed in hours not days ↓. Crack segmentation with 95% accuracy. Inspections of typical roof cut from hours to 30-60 mins ↓. Only targetted repairs/ patching required. Avoidance of major rework/ repair jobs.
8.	ESG/Environmental Management: Real-time Multispectral/ Hyperspectral Sensing & Analysis of environmental concerns & impacts	AI-smart sensors can detect excessive noise and vibrations, industrial dust and pollution levels, vegetation health, contaminations, health-related hazardous materials and potential regional environmental (ESG) impacts.	Faster ESG/ environmental monitoring, rapid analysis and reporting and early detection of potential pollution/ hazards.	Reduction in remediation costs or excessive repair expenses due to early detection. Risk reduction of regulatory penalties/fines ↓.

Top 8 AI-powered Drone Solutions: Operational Benefits and % Cost Savings



Source: modified from projectgo.pro and geospatialworld.net

Strategic AI-Powered Drone Solutions Towards Business Success

Practical application of AI-powered drones can greatly enhance the efficiency and the production economics of the respective dynamic construction companies worldwide. Another prime benefit is the innovative option for Government departments/agencies, industry captains, professional consultants, equipment manufacturers and site administrative personnel to confidently manage their tasks more effectively, economically, occupationally safe with increased worksite productivity while still responsibly enhancing Environmental Social & Governance (ESG) practices.

The table here highlights the top 8 strategic and economic applications of smart AI-powered drones, complemented with operational benefits and cost savings.

Conclusion

One of the prime benefits in the latest trends of rapid digital technology development is the lower cost of drone ownership when compared to the earlier pioneer drone models. The logistics and cost benefits in the use of commercial drones in construction projects include over 99% task result accuracy, the ability to safely complete the task by up to 85% faster and cost savings of up to 5 times cheaper for project implementation when compared with traditional work practices.

The other project operational reward includes improved accuracy in drone data collection phase via outputs of higher resolution images (2.6 cm/pixel resolution), an impressive tool for

more effective top management decision-making. Summary highlights on clear case benefits, in terms of costs, occupational safety and time saved in the innovative applications of AI-powered drones in world class construction business success include:

- Drone mapping can cut surveying costs by 30-60% and reduce survey time by 70-90% vs conventional ground surveys.
- Autonomous/AI-Drone enabled site inspections commonly reduce on-foot inspection labour costs and unsafe personnel safety practices by 40-70% while giving faster hazard detection alerts.
- Combined automation, Digital Twin and AI-incorporated infrastructure site planning, design and eventual construction typically deliver 5-25% improved work progress efficiency whereas asset uptime and maintenance savings add up an extra benefit of 10-30% in many construction tasks.

A new exciting AI-smart engineering and technological industrial age is at hand. By confidently incorporating AI-powered drone technology into daily operations, resourceful engineering professionals and the construction industry can confidently propel this vital industrial sector to reach new heights globally with respect to confident business success and site work productivity. The AI-powered Drone is the strategic operational technology foresight of the construction industry for improved efficiency, better occupational safety, and enhanced environmental governance with substantial cost savings for a smarter construction industry worldwide. 🤖

Common Compliance of ESG in Construction Industry for Malaysia: A Comparative Analysis

by
Ir. Jess Vun Wey Tyng

E KONSULT

The construction sector is a fundamental driver of global economic growth, yet it exerts a profound environmental and social footprint. According to the United Nations Environment Programme (UNEP), the buildings and construction industry is responsible for 37% of global energy-related and process carbon dioxide emissions as well as being the largest consumer of raw materials (UNEP, 2023).

In this context, the Environmental, Social & Governance (ESG) framework has emerged as a critical benchmark for sustainable investment and operational integrity, increasingly demanded by stakeholders worldwide. This article examines the common areas of ESG compliance taking root in the Malaysian construction industry, while drawing comparative lessons from more mature markets such as the United Kingdom (UK) and Singapore, to chart a path for accelerated sustainable development.

Environmental Pillar: From Voluntary Ambition to Regulatory Imperative

Environmental stewardship is often the most visible aspect of ESG, focusing on mitigating the ecological footprint of construction activities, from resource extraction to building operation.

In Malaysia, the primary driver for environmental compliance is the Green Building Index (GBI), a voluntary rating system for assessing buildings based on six key criteria: Energy efficiency, indoor environmental quality, sustainable site planning, materials and resources, water efficiency, and innovation (Green Building Index, 2023). Government initiatives, such as the National Policy on Climate Change 2.0, further underscore a national commitment to a low-carbon economy, affirming the goal of achieving net-zero greenhouse gas (GHG) emissions by 2050 (Ministry of Environment and Water, Malaysia, 2021).

Country	Compliance Mechanism	Key Differentiator	Challenges
Malaysia	Green Building Index (GBI) (Voluntary Rating)	Market-led adoption. Focus on design features.	Lack of mandatory benchmarks and public operational disclosure.
Singapore	Green Mark (BCA) (Mandatory for New/ Major Retrofits ≥ 5,000 m ²)	Mandatory minimum energy performance and cooling system audits for new and existing buildings.	High embodied carbon in imported materials. Complexity of value chain (Scope 3) decarbonisation.
United Kingdom	BREEAM (Life-cycle Assessment) and SECR (Mandatory Disclosure)	Regulatory requirement for public disclosure of energy and carbon emissions (Scopes 1 & 2).	Creates powerful financial and reputational pressure for decarbonisation across life-cycle.

Singapore, due to its land constraints and commitment to sustainability, has adopted a more regulatory-driven approach. Its Building and Construction Authority (BCA) Green Mark is mandatory for all new buildings and existing buildings undergoing major retrofitting works with a gross floor area (GFA) of 5,000 sq m or more (BCA, 2021). This legislative requirement ensures a verifiable, sustained minimum environmental standard, specifically focused on a high degree of energy efficiency and regular mandatory energy audits of building cooling systems.

In contrast, the United Kingdom employs the rigorous, life-cycle based BREEAM (Building Research Establishment Environmental Assessment Method) (BRE Group, 2023). Critically, the UK mandates transparency through Streamlined Energy and Carbon Reporting (SECR), which requires large companies to publicly disclose their energy consumption and carbon emissions (Scopes 1 and 2), creating a powerful financial and reputational incentive for decarbonisation (UK Government, 2023). Its blend of a robust assessment tool with mandatory disclosure regulations creates a more comprehensive and enforceable ecosystem.

Social Responsibility & Workforce Welfare: Holistic vs. Compartmentalised Approach

The social dimension of ESG addresses the impact of the construction industry on humans, from workers to communities.

In Malaysia, the focus traditionally centred on foundational workforce safety through the Construction Industry Development Board (CIDB) Green Card programme, a mandatory competency certification for all on-site personnel (CIDB Malaysia, 2023). While crucial, the industry faces systemic social challenges regarding the welfare of its large migrant labour force.

Singapore offers a compelling contrast by integrating social criteria directly into its sustainability framework. The BCA Green Mark scheme explicitly awards points for social features such as universal design principles and superior indoor environmental quality (BCA Singapore, 2023). Safety is enforced through the stringent Workplace Safety & Health Act, which imposes severe penalties for breaches (Ministry of Manpower Singapore, 2023), promoting a culture of high safety accountability.

Country	Compliance Focus	Mechanism Detail	Key Differentiator/ Gaps
Malaysia	Workforce Safety (CIDB Green Card)	Green Card programme mandates basic safety training. Often reactive on migrant worker welfare.	Social metrics are not central to the GBI. Lacks standardised, mandatory welfare and community engagement.
Singapore	Occupant/ Community Well-being & Safety	BCA Green Mark integrates social criteria (e.g., universal design, indoor air quality). Stringent Workplace Safety and Health Act penalties enforce a culture of accountability.	Proactively weaves social well-being into the very definition of a “sustainable” building.
UK	Social Value, Human Rights & Supply Chain Transparency	Public Services (Social Value) Act 2012 mandates public authorities consider social and environmental impact in procurement (e.g., job creation, skills). Modern Slavery Act 2015 requires large companies to publish annual statements on efforts to tackle modern slavery in their supply chains.	Focus shifts from just workforce safety (Health & Safety Executive enforcement) to broader, measurable community benefit and ethical supply chain due diligence.

The UK approach to the “S” is distinctively driven by two major legislative pillars. The Public Services (Social Value) Act 2012 requires public authorities to consider how their procurement, including construction, can secure wider social, economic, and environmental benefits, shifting the focus to a proactive community contribution. Furthermore, its Modern Slavery Act 2015 requires large companies to publish a public Modern Slavery Statement, detailing steps taken to prevent modern slavery and human trafficking in their operations and supply chains (UK Government, 2015), enforcing ethical supply chain due diligence relevant to migrant labour concerns.

Governance and Ethical Frameworks: The Supply Chain Imperative

Strong governance is the critical backbone that ensures environmental and social commitments are translated into tangible action, managed transparently, and upheld ethically.

In Malaysia, the governance framework is evolving. The Malaysian Anti-Corruption Commission (MACC) advocates for tools such as the Integrity Pact to prevent bribery (MACC, 2022). For public-listed companies, Bursa Malaysia’s Sustainability Reporting Guide mandates the disclosure of ESG practices

Country	Compliance Mechanism	Enforcement and Scope	Recent Progress
Malaysia	Bursa Malaysia Sustainability Reporting, MACC Integrity Pact, SEDG	Mandatory disclosure for listed companies. Voluntary or project-specific anti-corruption tools. The Simplified ESG Disclosure Guide (SEDG) targets SMEs in the supply chain.	The SEDG is a significant step to standardise reporting for sub-contractors and suppliers, meeting international demands.
Singapore	Singapore Exchange (SGX) Sustainability Reporting (Comply or Explain, with mandatory elements). Code of Corporate Governance. Prevention of Corruption Act	Mandatory for all SGX-listed companies to issue an annual sustainability report. Requirements include Board statement on sustainability and disclosure of material ESG factors (including anti-corruption and supplier assessment practices). Transitioning to mandatory climate-related disclosures (Scope 1 & 2 GHG) based on ISSB Standards (IFRS S1 & S2) from FY2025 onwards for all listed issuers.	SGX requirements push listed companies to establish formal board oversight and disclose material ESG factors which include supplier assessments and anti-corruption measures across the value chain. The shift to mandatory climate reporting based on ISSB ensures global compatibility and raises the bar for data quality and governance.
International	OECD Due Diligence Guidance	Requires companies to audit their entire supply chain for ethical risks, including labour abuses and corruption. Often backed by mandatory or liability-extending legislation (e.g., in the EU/UK).	Establishes a mandatory and enforceable standard of deep supply chain scrutiny.



(Bursa Malaysia, 2023). Crucially, the launch of the Simplified ESG Disclosure Guide (SEDG) helps the vast network of Small and Medium-sized Enterprises (SMEs) in the construction supply chain meet basic disclosure standards, aligning local practices with global supply chain demands (Capital Markets Malaysia, 2023).

Singapore's governance framework is primarily driven by the Singapore Exchange (SGX) for listed issuers. All listed companies must prepare an annual Sustainability Report on a "comply or explain" basis, which must include a Board statement on sustainability. A significant recent development is the phased move towards mandatory climate-related disclosures based on the global International Sustainability Standards Board (ISSB) standards (IFRS S1 & S2), beginning with Scope 1 and Scope 2 GHG emissions from FY2025 (SGX, 2023).

This necessitates stronger internal governance to manage and assure the accuracy of climate data, complemented by a robust Prevention of Corruption Act.

Internationally, the gold standard is set by frameworks such as the OECD Due Diligence Guidance for Responsible Supply Chains, which mandates scrutiny of the entire supply chain for ethical risks (OECD, 2016).

Conclusion: Bridging the Governance Gap for Sustainable Leadership

This comparative analysis shows that the Malaysian construction sector has established a solid foundation for ESG compliance, particularly through the GBI and the foundational CIDB Green Card programme, signalling a clear commitment to national green targets.

However, the path to accelerated sustainable development requires moving beyond voluntary compliance and foundational safety toward the comprehensive, mandatory frameworks seen in Singapore and the UK.

Singapore's mandatory minimum performance standards for energy and the integration of social criteria (e.g., universal design) into its Green Mark scheme represent the necessary shift from good design to guaranteed operational performance and human-centric outcomes.

The UK mandate for public disclosure of carbon emissions (SECR) and the enforcement of social value in procurement offers a blueprint for creating powerful market incentives and non-financial performance drivers.

For Malaysia to achieve sustainable leadership and remain competitive in a world increasingly demanding ESG data, the following strategic policy levers are critical:

1. **Mandatory Disclosures.** Introduce a phased, mandatory ESG disclosure regime for all large public and private construction projects, similar to Bursa Malaysia's requirements for listed entities, to drive transparency and accountability, especially on operational carbon and Scope 3 supply chain risks.
2. **Regulatory Benchmarks.** Transition the GBI from a purely voluntary rating to a system that sets mandatory minimum energy and water efficiency standards for all new buildings above a certain GFA, aligning with Singapore's performance-driven model.
3. **Governance in the Supply Chain.** Strengthen the enforcement mechanisms underpinning the MACC's Integrity Pact and accelerate the adoption of the SEDG across all tiers of the construction supply chain, specifically addressing forced labour and ethical sourcing, taking a cue from the UK's Modern Slavery Act.

By embedding mandatory, performance-based compliance mechanisms and strengthening supply chain governance, Malaysia can

effectively de-risk its construction sector, attract global sustainable investment, and translate its national net-zero ambition into verifiable environmental, social, and economic benefits. The future of our built environment lies in adopting governance that mandates performance, not just promises. 🏡

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Transformative Role of Building Materials in Construction Industry

by
Cheo Hong Keyong

The construction industry is a cornerstone of economic and social development, and its progress has always been closely tied to innovations in building materials. Materials not only determine the structural integrity, functionality, and safety of a building, but they also shape architectural possibilities and long-term sustainability.

In modern construction, the demand for taller, stronger, and more durable structures has driven the evolution from traditional stone, timber, and brick to advanced engineered composites and high-performance concretes. The role of building materials, therefore, is not merely functional but transformative, influencing cost, construction methods, and environmental impact.

Traditional Role of Building Materials

Historically, materials such as stone, wood, and clay were the backbone of early civilisations, with iconic structures such as Egyptian pyramids and Roman aqueducts demonstrating their durability.

With industrialisation, steel and concrete revolutionised construction. Concrete offered compressive strength, while steel provided tensile resistance, enabling innovations such as skyscrapers and long-span bridges. Timber remained significant, especially for residential and low-rise structures, prized for its availability and versatility. These traditional materials

continue to serve as the foundation of global construction but are increasingly supplemented, or even replaced, by new generations of materials designed to meet higher performance demands.

New & Emerging Building Materials

The modern construction environment demands materials which can withstand climate change, environmental degradation, and urbanisation pressures. Some of the most influential innovations include:

1. High-Strength and Ultra-High-Performance Concrete (UHPC)

- Traditional concrete typically achieves compressive strengths of 30–50 MPa, whereas UHPC can exceed 150 MPa, with enhanced ductility and durability.
- The reduced porosity of UHPC lowers the risk of water and chemical ingress, making it ideal for bridges, skyscrapers, and marine structures.
- Example: The Jakobstad Bridge in Finland incorporated UHPC for its thin deck sections, reducing dead load while improving strength.

2. Fibre-Reinforced Polymers (FRP)

- FRPs are composites of polymer matrices reinforced with glass, carbon, or aramid fibres. They are lightweight, corrosion-resistant, and extremely strong.



- Unlike steel reinforcement, FRPs do not rust, making them invaluable in coastal and maritime applications.
- Example: The Halls River Bridge in Florida was one of the first vehicular bridges built using GFRP (glass fibre-reinforced polymer) reinforcement to resist chloride attack from seawater.
- It exhibits superior resistance to sulphate attack and chloride penetration, which is especially beneficial for marine and coastal construction.
- Example: The Swan River pedestrian bridge in Perth, Australia, utilised geopolymer concrete to reduce carbon emissions and to enhance durability.

3. Self-Healing Concrete

- A breakthrough in durability, self-healing concrete contains bacteria or encapsulated healing agents that activate when cracks appear, sealing them automatically.
- This innovation reduces maintenance costs and extends the lifespan of infrastructure, particularly in underground tunnels and remote maritime environments where manual repairs are challenging.

4. Geopolymer Concrete

- Made from industrial by-products such as fly ash and blast furnace slag, geopolymer concrete is a sustainable alternative to Portland cement.

5. Engineered Timber (Cross-Laminated Timber, CLT)

- Beyond concrete and steel, engineered timber has gained traction for its sustainability and strength-to-weight ratio.
- It is renewable, stores carbon, and supports prefabrication, speeding up construction.
- Example: The Mjøstårnet building in Norway, the world's tallest timber building, demonstrates the capacity of CLT in high-rise construction.

Applications & Impacts

High-Rise Buildings: High-strength concrete was pivotal in the construction of the Petronas Twin Towers in Kuala Lumpur, where concrete, rather than steel, was chosen due to cost, availability, and stiffness, allowing the towers to withstand wind sway and to achieve record heights.

Maritime and Coastal Structures: The Hong Kong-Zhuhai-Macau Bridge (HZMB) applied specially designed concrete mixes with low permeability and additives to resist chloride and sulphate attacks in a highly aggressive marine environment. In oil and gas platforms, FRP reinforcements are increasingly used for the same reason.

Soil and Tunnelling Projects: In tunnelling projects such as London's Crossrail, fibre-reinforced sprayed concrete was used for linings, capable of accommodating soil movement while maintaining strength and stability.

Geosynthetics and soil-stabilising agents are also being adopted in large-scale excavation and foundation works to mitigate settlement issues.

Sustainability & Environmental Protection: The construction industry is responsible for nearly 40% of global carbon emissions. The adoption of low-carbon materials such as geopolymers and engineered timber directly addresses environmental concerns while supporting global climate goals.

Conclusion

Building materials are more than structural necessities; they are also enablers of innovation, sustainability, and resilience in construction. While concrete and steel continue to dominate, the advent of UHPC, FRPs, self-healing concrete, and sustainable alternatives like geopolymers and CLT is reshaping the industry.

These materials extend the service life of structures, reduce environmental impact, and open new frontiers in design. Whether it is resisting sulphate attack in marine bridges, addressing soil movement in tunnelling, or enabling supertall skyscrapers, new building materials are driving construction into a future where strength and sustainability go hand in hand. 🏗️

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Retrofitting & Rehabilitation of Ageing Infrastructure: Balancing Safety, Economics & Regulation

by
Chin Siew Yin

Feature



Well-preserved heritage site at Dubrovnik, Croatia, which is now a popular tourist destination during Repair Option Selection stage

Across the globe, bridges, roads, buildings, ports, and other critical infrastructure are ageing. Many of these assets are operating well beyond their original design life, often under increased usage loads and harsh environmental conditions. Without intervention, deterioration can lead to reduced safety, costly service disruptions, or even catastrophic failures.

Retrofitting and rehabilitation provide practical solutions to extend the life of these structures. Decision-making, however, goes beyond technical measures as it also requires careful economic evaluation and adherence to regulatory frameworks. In Malaysia, the Street, Drainage & Building Act 1974 (Act 133) underscores this principle by mandating periodic inspections of buildings over five storeys every 10 years.

Structural Safety & Durability

The foremost concern in infrastructure rehabilitation is structural safety. Ageing structures often suffer from:

- Cracking and spalling of concrete.
- Corrosion of reinforcing steel.
- Settlement due to weak foundations.
- Inadequate resistance to seismic or wind loads under outdated codes.

Modern retrofitting techniques address these issues effectively. Among the most widely applied are:

- Carbon-fibre reinforced polymer (CFRP) wrapping to increase load capacity.
- Steel jacketing of columns to restore strength and ductility.
- Seismic base isolators to improve earthquake resilience.
- Protective coatings and cathodic protection to safeguard marine and industrial structures.

These interventions not only restore safety but also extend the service life of critical assets.

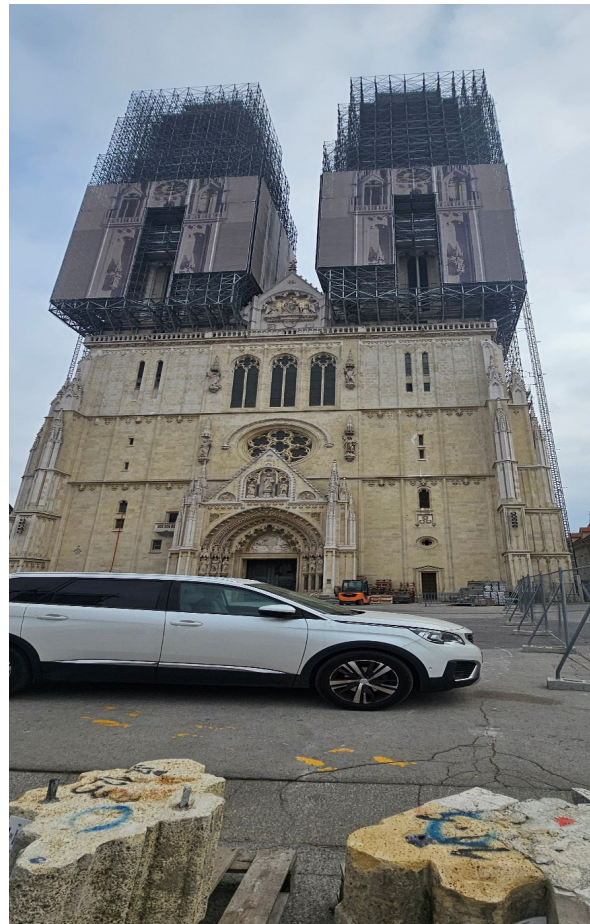
Condition Surveys & Appraisals

Effective rehabilitation begins with a systematic condition survey, enabling engineers to identify deterioration and prioritise interventions. Standard practices include:

- Visual inspections for distress.
- Non-destructive testing (NDT) methods such as ultrasonic scanning or rebound hammer tests.
- Material sampling for chloride content, carbonation depth, or compressive strength.
- Structural appraisals through load testing and computer modelling.

The appraisal outcomes determine whether a structure requires minor repairs, strengthening, or complete replacement.

Extra care was exercised in the rehabilitation of this historical building in Zagreb.



Extra care was exercised in the rehabilitation of this historical building in Zagreb.

Life-Cycle Costing & Economic Considerations

Although retrofitting may seem costly at the outset, it is often far more economical than full reconstruction when assessed through life-cycle costing (LCC) which considers:

- Direct costs (materials, labour, contractors).
- Indirect costs (traffic diversions, downtime, business disruptions).
- Long-term savings from extended service life and reduced maintenance.

Well-planned retrofitting ensures efficient use of limited public funds while preventing the massive financial and human losses associated with structural failures.

Worldwide Experiences in Infrastructure Rehabilitation

Experiences from around the world highlight both the risks of ageing infrastructure and the benefits of timely rehabilitation.

- Japan: Following the 1995 Kobe earthquake, extensive retrofitting, including base isolators and steel jacketing, greatly improved seismic resilience.
- United States: The 2007 collapse of the I-35W bridge in Minneapolis underscored the importance of continuous inspections and timely interventions.
- Scotland: The Forth Road Bridge was saved from premature closure through a cable dehumidification system which slowed down corrosion.
- Hong Kong: Aggressively exposed port structures were strengthened using cathodic protection and high-performance concrete.

Local Context

In Malaysia, ageing infrastructure, including high-rise residential blocks, flyovers, and drainage structures, faces increasing demand for systematic retrofitting. Commonly used techniques include CFRP wrapping, foundation strengthening, and advanced waterproofing systems.

A cornerstone of Malaysia's regulatory framework is the Street, Drainage & Building Act 1974 (Act 133), which mandates periodic inspections of buildings over five storeys every decade. These inspections involve visual inspections and detailed structural inspections by qualified engineers.

Based on findings, building owners may be required to undertake necessary repairs or retrofitting to ensure continued safety. This mandatory regime enables early detection of defects, preventing deterioration from escalating into serious failures.

“Global lessons confirm that early intervention saves both lives and money.”

Linking Safety, Economics & Regulation

Retrofitting and rehabilitation represent more than an engineering challenge. They require a balanced approach:

1. **Safety.** Protecting the public through robust structural strengthening and durability enhancement.
2. **Economics.** Applying life-cycle costing to optimise investments and long-term value.
3. **Regulation.** Enforcing preventive maintenance through legal frameworks such as Malaysia's Act 133.

When these three pillars align, societies can preserve critical infrastructure while managing costs and risks effectively.

Conclusion

Retrofitting and rehabilitation of ageing infrastructure have become indispensable in an era of rapid urbanisation and growing demand. Proactive measures extend service life, ensure public safety, and minimise economic disruptions.

Global lessons confirm that early intervention saves both lives and money. Malaysia's regulatory model, anchored in Act 133, demonstrates how engineering and law can be combined to safeguard the public.

Looking ahead, the integration of advanced materials, digital monitoring technologies, and proactive regulatory frameworks will shape the next generation of infrastructure management, enabling nations to build resilience while maximising the value of existing assets. 🏗️

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Heritage Conservation & Engineering in Historic Building Projects: South-East Asian Perspectives and Their Impact on UNESCO World Heritage Criteria

by
Peter Khoo Phooi Sen



Heritage conservation is a critical undertaking to preserve the cultural and architectural legacies of human civilisation. In South-East Asia, where centuries of trade, colonisation, and cultural exchange have left behind an eclectic mix of architectural treasures - from temples and mosques to colonial-era civic buildings - preservation is not only about memory, but also identity.

Engineering plays a pivotal role in this process, ensuring the physical survival of these structures while aligning with international charters such as those of International Council on Monuments & Sites (ICOMOS), which guide the listing and evaluation of UNESCO World Heritage Sites. The success or failure of engineering interventions can directly influence the status of a site under UNESCO by affecting key criteria such as authenticity, integrity, and Outstanding Universal Value (OUV).

South-East Asian Heritage Landscape

The region boasts a wide spectrum of architectural heritages - Borobudur in Indonesia, Angkor Wat in Cambodia, Luang Prabang in Laos, and the historic cities of George Town and Melaka in Malaysia, all of which are UNESCO World Heritage Sites. These sites are not just static relics but are also often part of living cities with functioning communities. This dynamic context adds layers of complexity to conservation, particularly in balancing preservation with urban development.

Engineering in Heritage Conservation: Protecting Structure & Spirit

Engineering in historic conservation goes beyond structural repair; it encompasses diagnostics, risk mitigation, material compatibility, and reversibility of intervention. In South-East Asia, where tropical climates, high humidity, and seismic activity pose constant threats to heritage buildings, engineering solutions must be both contextually and culturally sensitive. Key approaches include:

- **Non-Invasive Structural Analysis.** Engineers use laser scanning, photogrammetry, and ground-penetrating radar to map conditions without damaging original materials.
- **Traditional Material Science.** Techniques such as using lime mortar instead of cement in old masonry walls, are crucial for maintaining material breathability and historic accuracy.
- **Climate-Responsive Adaptation.** In tropical cities such as Melaka, engineers integrate natural ventilation and humidity control to prevent mould and deterioration.
- **Seismic Retrofitting.** In regions such as Bali or the Philippines, where earthquakes are common, base isolators or fibre-reinforced polymers are used to discreetly enhance resilience.

ICOMOS & Impact of Engineering on UNESCO Criteria

ICOMOS evaluates nominated or listed sites against 10 criteria set by UNESCO. For cultural properties, these include:

- **Criterion (ii).** Exhibiting interchange of human values.
- **Criterion (iv).** Exemplifying significant architectural or technological ensembles.
- **Criterion (vi).** Being directly associated with events or traditions of universal significance.

Two cross-cutting attributes that must be preserved are:

- **Authenticity.** Faithfulness to the original materials, design, setting, and workmanship.
- **Integrity.** Wholeness and intactness of the property.

Engineering interventions that introduce inappropriate materials (e.g., concrete replacing timber), distort historical context (e.g., adding high-rise structures within heritage zones), or lead to partial demolition risk undermining both authenticity and integrity, jeopardises a site's standing under ICOMOS evaluation.

George Town & Melaka (Inscribed 2008)

These two historic port cities were inscribed under Criteria (ii), (iii), and (iv) for their blend of Malay, Chinese, Indian, and European influences. Engineering has a vital role in their continued conservation.

- **Structural Rejuvenation of Shophouses:** In George Town, hundreds of pre-war shophouses, built with timber joists, lime plaster, and clay bricks, were structurally assessed using non-destructive methods. Engineers devised reversible methods to reinforce sagging floors and to retrofit roofs, ensuring minimal loss of original material. Lime plaster, rediscovered and reapplied using traditional skills, prevented moisture entrapment.
- **Stormwater Drainage and Rising Damp:** In Melaka, rising damp from high water tables was causing severe deterioration. Engineers designed concealed French

drain systems and moisture barriers to divert groundwater while maintaining the heritage streetscape.

- **Conflict with Modern Infrastructure:** Despite the many successes, challenges persist. The construction of high-rise hotels and intrusive signage near heritage zones triggered warnings from UNESCO and prompted calls for better urban planning to preserve visual integrity.

Other South-East Asian Examples

Borobudur, Indonesia: One of the world's largest Buddhist temples, Borobudur faced structural instability due to earthquakes and volcanic ash deposition. Engineering teams used digital scanning and load-distribution modelling to stabilise the massive stone stupas. UNESCO closely monitors interventions to ensure that traditional stone masonry techniques are respected, and reversible methods are prioritised.

Hoi An, Vietnam: Known for its timber-framed buildings and waterfront trade history, Hoi An experienced flooding and salinity damage. Engineering projects helped elevate vulnerable sections while using flood-resistant lime plaster and wood treatments, ensuring the town retained its OUV under Criteria (ii) and (v).

ICOMOS Guidelines & Engineering Ethics

All conservation engineering efforts must be guided by ICOMOS charters.

- The Venice Charter (1964). Stresses minimal and distinguishable intervention.
- The Burra Charter (Australia, 1979). Encourages understanding the cultural significance before any intervention.
- Principles for Preservation of Historic Timber Structures. Particularly relevant in South-East Asia, where timber is a primary material.

Failure to adhere to these principles may result in:

- A site being placed on the List of World Heritage in Danger.
- Loss of UNESCO status if authenticity or integrity is significantly compromised.
- Rejection of nominations for future heritage listings.

Future Path: Technology, Community & Capacity Building

Increasingly, Malaysia and her neighbours are investing in heritage technology, such as Heritage Building Information Modelling (HBIM), real-time condition monitoring, and climate-adaptive engineering. However, there is a need for:

- Training of local engineers and craftsmen in traditional methods and conservation principles.
- Community participation to ensure conservation respects local identity and use.
- Integrated master planning to regulate development pressures near heritage zones.

The Department of National Heritage, under the Ministry of Tourism, Arts & Culture, now works closely with local governments and NGOs to guide conservation works, particularly in Penang and Melaka.

Conclusion: Engineering as Cultural Stewardship

Engineering in heritage conservation, especially within UNESCO-listed sites, is more than a technical task; it is also cultural stewardship. In South-East Asia, where rapid modernisation competes with historic preservation, engineering must rise to the challenge of safeguarding the past while supporting future use. By aligning engineering practice with ICOMOS charters and UNESCO criteria, nations such as Malaysia can ensure that their tangible heritage continues to educate, inspire, and belong. The integrity and authenticity of heritage sites are not just bureaucratic metrics but are also the soul of civilisation's story. 🏛️

Navigating Change: The Maritime Silk Road's Transformation of 21st Century Shipping & Trade

by
Ong Em Nee

The Maritime Silk Road (MSR) - the maritime arm of China's Belt & Road Initiative (BRI) - is reshaping global shipping patterns, logistics networks, and investment flows in the 21st century. By linking upgraded ports, coastal industrial zones, and integrated transport corridors, the aim is to shorten supply chains, increase capacity, and deepen economic ties across Asia, Africa, and Europe. Its ripple effects are especially visible in ASEAN, a region that sits astride some of the world's busiest sea lanes and is strategically positioned to benefit from, and to respond to, new maritime infrastructure and trade realignments.

Global & Regional Shifts in Shipping and Trade

The MSR advances three interlocking trends:

1. Infrastructure-led connectivity, where investments in ports and hinterland links lower effective transport costs.
2. Technological upgrade, as ports adopt automation and digital logistics.
3. Network resilience, with alternate routings and transshipment options that reduce single-point vulnerabilities.

Recent research shows that enhancing maritime corridors under the MSR has materially improved regional shipping resilience and redistributed trade flows toward corridors linked to upgraded port infrastructure. These shifts change where vessels call, how cargo is aggregated, and which hubs capture value from global supply chains.

Influence on ASEAN: Opportunities & Patterns

ASEAN nations sit at the geopolitical and commercial heart of the MSR. Upgraded ports and expanded maritime services are producing measurable gains in throughput and transshipment activity across the region. For Malaysia in particular, ports such as Port Klang and Port of Tanjung Pelepas (PTP) have recorded notable throughput increases in recent years, underscoring the country's growing importance as a transshipment and gateway hub. Port Klang reported a new historical high of 14.64 million TEUs in 2024, with PTP also posting double-digit growth. Together they account for a substantial portion of total container volumes. These performance improvements reflect both domestic capacity upgrades and wider shifts in regional routing and trade patterns.



ASEAN's broader response includes coordinated efforts to improve customs harmonisation, port interoperability, and multimodal connections - moves that amplify the benefits of MSR-linked investments and situate the bloc as a critical node between East Asia, South Asia, and beyond.

Construction Projects Along the MSR: Scale, Types & Local Effects

MSR investment often manifests as large-scale port modernisation, terminal expansion, dredging, reclamation, industrial park construction, and associated road/rail links. These projects demand extensive civil works (quays, breakwaters, yard pavements), geotechnical engineering (soil improvement, piling), marine engineering (dredging, scour protection), and heavy mechanical/electrical installations (cranes, yard automation). The cumulative effect is a sustained pipeline of construction contracts that both attract foreign capital and stimulate local supply chains - materials, specialised machinery, and engineering services.

However, project outcomes vary. Some large schemes have been scaled down, delayed, or reconfigured to reflect commercial realities and environmental concerns (e.g., the Melaka

Gateway project has been downsized from original mega-ambitions to a more modest port/cruise terminal development). Project delivery patterns therefore range from high-quality, turnkey modernisations that lift regional capacity to contested projects that raise questions about viability and sustainability.

Specific Impacts on Malaysia: Construction, Engineering Services & The Maritime Industry

1. Construction & Civil Works

Port expansions and new developments generate immediate demand for civil, marine, and geotechnical engineering for deepening berths, building container yards, creating intermodal links, and performing reclamation and seawall works.

Large CAPEX commitments - both public and private - drive local demand for contractors, subcontractors, and material suppliers. For example, capacity and automation upgrades at major terminals require sophisticated foundation works and heavy-duty pavements to support container crane loads and high throughput.

2. Engineering & Technical Services

The MSR has expanded opportunities for Malaysian consulting engineers, naval architects, and specialist firms. There is heightened demand for:

- Marine engineering (dredging design, scour protection, berth design).
- Geotechnical services (soil improvement for reclaimed land, pile design).
- Port systems & automation (terminal operating systems, quay-crane integration).
- Environmental and resilience planning (climate-proofing, coastal erosion mitigation).

Collaboration with international engineering firms on complex MSR projects fosters technology transfer - digital engineering, BIM, and integrated logistics planning - which strengthen local capability and enhance the competitiveness of Malaysian firms in regional bidding.

3. Maritime Industry & Ancillary Services

Higher port throughput translates into greater activity across ship-related services: Ship repair and maintenance yards, bunkering, ship agency services, and maritime training institutions. As ports modernise, Malaysia stands to capture more value by developing specialised repair facilities, marine equipment supply chains, and human capital for modern terminal operations. Moreover, green port initiatives (IMO compliance, cleaner fuels, energy-efficient operations) create niche demand for environmental engineering and retrofitting services.

Economic and strategic opportunities include:

- Export and manufacturing linkages. Improved maritime connectivity shortens lead times for exporters and enhances competitiveness for manufacturers dependent on just-in-time logistics.

- Cluster development. Port-adjacent industrial parks and logistics zones attract value-added activities (assembly, packaging, and light manufacturing), creating multiplier effects for local economies.
- Skill and technology upgrading. MSR projects often require advanced engineering skills and digital systems, creating room for workforce upskilling and knowledge transfer.

Environmental, Financial & Geopolitical Challenges

Despite the opportunities, several challenges must be managed:

1. Environmental impacts. Dredging, reclamation, and intensified port activity can harm coastal ecosystems, fisheries, and shoreline stability unless mitigated through stringent environmental assessment and adaptive engineering measures. Evidence from regional studies highlights risks to coastal livelihoods and biodiversity if mitigation is weak.
2. Debt and financing concerns. Large infrastructure projects financed through external loans or state-owned enterprise arrangements may raise debt sustainability concerns when projected traffic or returns fall short. Transparent contracting, rigorous cost-benefit analysis, and local participation are essential to ensure projects deliver net benefits.
3. Geopolitical sensitivities: MSR investments operate within a geopolitical context - partner countries must balance economic gains with sovereignty concerns and regional power dynamics. ASEAN's push toward economic integration seeks to manage external influences while maximising regional benefits.



Pathways for Sustainable Growth in Malaysia & ASEAN

1. Strengthen local content and capacity building: Ensure MSR projects include clear local-supplier participation, training provisions, and joint ventures to maximise technology transfer.
2. Enforce environmental safeguards and resilience design: Require high engineering and environmental standards - coastal modelling, sediment management, and climate adaptation measures - to reduce long-term ecological and economic risks.
3. Promote interoperability and digital integration: Invest in port community systems and customs harmonisation so that upgraded physical capacity translates into faster clearance and lower logistics costs across ASEAN.
4. Diversify financing and risk sharing: Use blended finance, public-private partnerships with transparent terms, and phased investments tied to performance benchmarks to mitigate fiscal risk.
5. Advance regional coordination: ASEAN-level coordination on standards, data sharing, and multimodal planning will amplify the benefits of individual projects and reduce duplication.

Conclusion

The Maritime Silk Road is a 21st century catalyst for reshaping shipping, trade, and maritime infrastructure. For ASEAN, and

Malaysia in particular, the MSR has delivered measurable throughput gains, galvanised construction and engineering activity, and accelerated the modernisation of maritime services. But the gains are neither automatic nor evenly distributed. Realising the MSR's long-term promise requires robust engineering standards, environmental stewardship, inclusive local participation, and prudent financing. With strategic policy choices and industry readiness, Malaysia and its ASEAN partners can turn MSR-linked investments into enduring platforms for sustainable growth and deeper regional integration. 🌐

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Role of Engineers in Good Urban Governance

by
Chin Fong Yin

Urban governance is a cornerstone of sustainable development in the 21st century. As cities grow in size, population, and complexity, the need for effective governance becomes ever more critical. Good urban governance ensures that cities are well-planned, inclusive, economically vibrant, environmentally sustainable, and socially cohesive.

For Malaysia, a rapidly urbanising nation with ambitions to become a high-income, developed country, the performance of its urban governance systems and the contributions of its engineering community are pivotal. This article explores the importance of good urban governance, Malaysia's performance in this area, and the vital role engineers play in shaping the country's urban future.

Importance of Good Urban Governance

Good urban governance refers to the processes and structures that guide, manage, and steer the growth and development of urban areas. It encompasses transparency, accountability, participation, effectiveness, efficiency, equity, and sustainability in decision-making and service delivery.

Firstly, good governance is essential to ensure that urban development is inclusive. Cities must cater to the needs of all residents, including marginalised groups, to foster social harmony and economic opportunity. Transparent and participatory governance allows citizens to



influence decisions that affect their lives, leading to better alignment of policies with community needs.

Secondly, effective urban governance is crucial for sustainable development. Cities are major contributors to environmental degradation but are also hubs of innovation and solutions. Good governance ensures that urban planning prioritises environmental stewardship through green spaces, public transport, waste management, and climate resilience.

Finally, good governance fosters economic vitality. Well-governed cities attract investment, create jobs, and support innovation. Efficient infrastructure provision and regulatory clarity lower transaction costs and enhance competitiveness.

Malaysia's Performance in Urban Governance

Malaysia's urban governance performance has shown significant progress over the decades, though challenges remain. The country's urbanisation rate has surpassed 77%, with cities like Kuala Lumpur, Penang, Johor Bahru, and Kota Kinabalu becoming engines of national growth.

The government has implemented various national frameworks aimed at improving urban governance, including the National Urbanisation Policy and Malaysia Smart City Framework. Efforts to modernise city management through digitalisation, public-private partnerships, and sustainability initiatives are evident.

For example, Kuala Lumpur's City Hall (DBKL) has launched smart city projects involving intelligent transport systems, e-government services, and environmental monitoring. The Low Carbon Cities Framework (LCCF) encourages local authorities to embed sustainability into urban planning.

However, governance challenges persist. Coordination across federal, state, and local levels is often less coordinated, leading to overlapping responsibilities. Public participation in planning remains limited, with top-down approaches still prevalent. Moreover, issues such as traffic congestion, affordable housing shortages, and environmental degradation point to the need for stronger integrated governance and enforcement.

Role of Engineers

Engineers are indispensable actors in urban governance. Their technical expertise, problem-solving skills, and commitment to public welfare allow them to contribute significantly to the planning, design, implementation, and maintenance of urban systems.

Firstly, engineers play a critical role in infrastructure development. Roads, bridges, water supply, energy grids, public transport, and

digital networks form the backbone of urban life. Engineers ensure that these systems are safe, resilient, and efficient, thereby enhancing urban quality of life.

Secondly, engineers contribute to sustainable urbanisation. By incorporating principles of green design, renewable energy, resource efficiency, and climate adaptation, engineers help cities meet sustainability goals. Innovations in building materials, smart grids, and waste recycling are often led by engineers.

Thirdly, engineers support evidence-based policymaking. Through data collection, modelling, and analysis, they provide insights that enable better urban planning. Technologies such as geographic information systems (GIS), digital twins, and IoT (Internet of Things) platforms are transforming how cities are managed, with engineers at the forefront of this digital revolution.

Furthermore, engineers can advocate for participatory and ethical governance. By engaging with communities, promoting transparency in project delivery, and adhering to professional codes of conduct, they help foster trust in urban governance processes.

Conclusion

Good urban governance is vital for building inclusive, sustainable, and prosperous cities. Malaysia has made commendable strides in this area, yet the journey towards fully effective and participatory governance continues.

With their unique blend of technical expertise and societal responsibility, engineers are key enablers of this progress. As we move forward, the integration of engineering innovation with governance reforms will be essential to achieving urban development aspirations. By embracing interdisciplinary collaboration and citizen engagement, engineers can help shape cities that truly serve the needs of present and future generations. 🌐

Role of Engineering under the UNCLOS Biodiversity Beyond National Jurisdiction (BBNJ) Agreement

by
Lim Tau Wee

The BBNJ Agreement, adopted on 19 June 2023, is the first comprehensive, legally binding framework under UNCLOS which targets marine biological diversity in areas beyond national jurisdiction (ABNJ). Its four pillars - marine genetic resources (MGRs), area-based management tools (ABMTs including MPAs), environmental impact assessments (EIAs), and capacity building and transfer of marine technology (CB&TMT) - constitute a robust platform for engineering-based applications.

Among these, the engineering aspect manifests most clearly in EIAs, ABMTs (including design, monitoring, enforcement), and technology transfer for marine science infrastructure and operations.

Environmental & Strategic Impact Assessment (EIA/SEA)

EIAs under the BBNJ Agreement require that any planned activity in ABNJ likely to affect the marine environment - and especially if its effects are unknown or potentially significant - must undergo assessment before authorisation. Such assessments include screening thresholds and detailed impact evaluation, considering factors like technology used, ecosystem vulnerability, duration, location, cumulative effects, and related activities.

Equally, the treaty endorses Strategic Environmental Assessments (SEAs) or broader, plan- or programme-level evaluations that complement EIAs. SEAs inform EIAs by supplying regional environmental context, identifying data gaps, and supporting informed decision-making.

The Scientific & Technical Body will develop standards and guidelines for these processes, in close coordination with sectoral and legal frameworks.

Use of Resources & Engineering Technologies

Though engineering is not formally defined in the Agreement, its tools and methods underpin effective conservation and sustainable use. A suite of advanced technologies is pivotal.

- Remote sensing (satellites, AIS, SAR), autonomous and glider-based monitoring platforms, eDNA sampling, and sensor networks provide environmental surveillance and data gathering in remote ABNJ.
- Deep-sea exploration relies on ROVs, HOVs, and other advanced sampling systems to access and study resource-rich zones.
- Novel monitoring networks (fixed seabed platforms, mobile docked units, optoacoustic imaging, and in-situ eDNA sequencing) are being developed for continuous and

autonomous biodiversity and ecosystem monitoring. Such technologies are essential to support EIAs, ABMTs, and enforcement capabilities under the treaty framework.

Capacity-Building & Transfer of Marine Technology

A cornerstone of the BBNJ Agreement is technology transfer and capacity building, designed to bridge capability gaps among parties, especially developing, land-locked, and geographically disadvantaged states. The agreement defines marine technology broadly: Data, manuals, equipment, observation systems, software, biotechnology, and technical expertise. Capacity building may include:

- Sharing of marine science data, research results, guidelines, and standards.
- Developing infrastructure (e.g. equipment for sampling, data systems).
- Strengthening institutional, legal, and regulatory frameworks.
- Enhancing human and financial capacities via training, exchanges, and technical cooperation.

The process is envisioned as country-driven, transparent, participatory, and gender-responsive, with technology sharing on fair, concessional, and mutually agreed terms. Periodic monitoring and review via specialised committees will help adapt the capacity-building agenda to evolving needs.

Malaysia, with its strategic marine interests, technical institutions, and biodiversity-rich ecosystems, is well-positioned to both contribute to and benefit from the BBNJ framework.

- 1. Infrastructure & Expertise.** Malaysia's academic institutions and research centres (e.g. marine technology, marine parks) can contribute data, baseline research, and technical capacity to global EIA and SEA initiatives.
- 2. Regional Leadership & Collaboration.** Through ASEAN or regional seas mechanisms, Malaysia can lead collaborative

monitoring platforms, share guidelines, and contribute to ABMT proposals or MPA design.

- 3. Technology Development & Biomimetic Innovation.** Malaysia's unique marine biodiversity can inspire biomimetic engineering solutions. The concept of 3D Corporate Tourism in marine sciences has already explored such innovation, enabling on-site, sustainable engineering inspired by marine ecosystems without exploiting them.
- 4. Capacity-Building Recipient & Provider.** Malaysia may actively engage in receiving advanced technology, e.g. ROVs, eDNA platforms, data systems, to monitor ABNJ. Conversely, with its growing technical capacity, Malaysia can provide training and collaborative opportunities to other developing states, reinforcing South-South cooperation.
- 5. Policy & Legal Development.** Malaysia can refine domestic regulations and institutions that align with BBNJ requirements, while contributing case studies and best practices to the treaty's development of guidelines and governance mechanisms.

Conclusion

The BBNJ Agreement embeds engineering and technology at the heart of advancing conservation and sustainable use in the high seas. Environmental assessments require robust monitoring systems while ABMTs rely on spatial planning and enforcement technologies and capacity building ensures equitable participation.

Malaysia's scientific infrastructure, marine expertise, and innovative approaches such as biomimicry and institutional capacity, position it as both a contributor to global marine governance and a key beneficiary of technology transfer and capacity building under the BBNJ framework. By engaging proactively, Malaysia can reinforce its leadership in marine science and help shape the application of engineering solutions for a sustainably managed global ocean. 🌊

Global Governance of Deep-Sea Mining: Balancing Resources & Responsibilities

by
Lee Soo Leng

Deep-sea mining, the extraction of mineral resources from the ocean floor beyond (and within) national jurisdictions, raises novel governance, environmental and technical questions. International governance is centred on the United Nations Convention on the Law of the Sea (UNCLOS) and, under UNCLOS, the International Seabed Authority (ISA). The ISA is the organisation mandated to regulate mineral activities in the seabed beyond national jurisdiction (referred to as the “Area”), to issue exploration and (eventually) exploitation contracts as well as to ensure that activities in the Area benefit humankind as a whole while protecting the marine environment.

To operationalise this mandate, ISA has developed an institutional framework:

1. Rules and regulations to be adopted as an internationally agreed “mining code”.
2. Environmental assessment and monitoring requirements.
3. mechanisms for financial terms and benefit-sharing.
4. A system where state parties sponsor entities (companies or state bodies) that apply for exploration rights.

The ISA also issues guidance on environmental baselines, standards for environmental impact assessment (EIA), and requirements for an inventory of hazardous materials.

Only states that are parties to UNCLOS are bound by ISA rules. If a private company wants to mine in the Area, it must be sponsored by an ISA member state. That state must ensure the company complies with ISA rules. This is known as the Sponsoring State Obligation (UNCLOS Annex III, Article 4).

Non-compliance can lead to:

- Suspension or termination of exploration contracts.
- Financial liability for the sponsoring state.
- Disqualification from future contracts.

Current Scenario

By mid-2024 the ISA had issued numerous exploration contracts to state agencies and private companies from a range of countries. These contracts covered different resource types (nodules, sulfides, crusts) in various regions such as the Clarion-Clipperton Zone (CCZ) in the Pacific, mid-ocean ridges, and seamounts. However, commercial exploitation had not yet begun on a large scale. There has been intense debate over when (and whether) to permit exploitation licences: The ISA has been working to complete and adopt its Mining Code (the exploitation regulations) but progress has been contentious.

Parallel to ISA activity, a strong international campaign by scientists, many environmental NGOs and some states argued for a precautionary

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 Deep-sea ecosystems are generally
 slow-growing, highly endemic, and
 adapted to stable, low-nutrient conditions.
 ”

pause or moratorium until the environmental risks and governance arrangements were better understood. The political dynamic has been polarised: Some resource-rich small island states and commercial actors have urged moving toward exploitation for economic opportunity, while many conservation-oriented states and scientists press for restraint. Overall, the field in 2024 was characterised by active exploration, incomplete exploitation regulations, growing scientific evidence of potential harm, and a fraught political debate about timing and safeguards.

Types of Deep-Sea Mining

There are three principal types of deep-sea mineral targets and associated extraction approaches:

1. Polymetallic (manganese) nodules. Nodules are potato-to-boulder sized mineral concretions lying loosely on abyssal plains (4,000m to 6,000m depth). They contain manganese, nickel, copper, cobalt and rare earth elements. Extraction concept: Seabed collection vehicles that vacuum or scoop nodules from the seafloor and pump them to a surface vessel.
2. Polymetallic (seafloor) sulfides. Found around hydrothermal vents on mid-ocean ridges and back-arc basins. Sulfides can

be metal-rich but occur in biologically active vent ecosystems. Extraction concept: Cutting/collecting chimney and deposit material from vent fields, with subsea mining tools.

3. Cobalt-rich ferromanganese crusts (on seamounts). These form as coatings on seamount flanks and contain cobalt, platinum and tellurium. Extraction concept: Scraping or cutting crusts from rock surfaces on steep slopes - very challenging technically and ecologically sensitive.

Each type differs in geology, depth, biomass association, and likely environmental impacts; they therefore require different engineering and regulatory approaches.

Environmental Impacts & Scientific Concerns

Deep-sea ecosystems are generally slow-growing, highly endemic, and adapted to stable, low-nutrient conditions. Key environmental concerns include:

- Habitat loss and extinction risk. Direct removal or destruction of seabed habitat (nodules, vent chimneys, seamount crusts) erases microhabitats supporting unique species, many unknown to science.

- Sediment plumes and smothering. Mining operations generate sediment plumes both at the seabed (bottom plumes) and in the water column during transport to surface vessels (surface plumes). These can smother benthic life, reduce filter-feeding efficiency, and propagate impacts across large areas.
 - Biodiversity impacts with slow recovery. Experiments and long-term studies show that recolonisation at abyssal depths is extremely slow. It can take decades to centuries for complex communities and some functions may not recover at all.
 - Biogeochemical and carbon cycle effects.: Disturbance can remobilise stored carbon in sediments and alter microbial processes, with uncertain implications for carbon sequestration and trace-metal cycling.
 - Cascading ecosystem changes: Impacts on keystone or foundation species can have wider ecological consequences throughout food webs.
3. Transboundary and cumulative effects. Plumes and ecological impacts do not respect contract boundaries. Coordinating monitoring and mitigation across operators and international waters is difficult.
 4. Enforcement and verification. Monitoring remote, deep operations requires expensive technology and independent verification mechanisms. Ensuring compliance with environmental terms, real-time monitoring, and meaningful sanctions raises capability issues for the ISA and flag/sponsoring states.
 5. Equity, benefit-sharing and legal complexity: UNCLOS requires activities in the Area to benefit humankind. Translating this into fair monetary or non-monetary benefit-sharing (especially for developing states) is complex and politically sensitive.
 6. Commercial and technological risk. Deep-sea mining technologies are largely unproven at scale. Financial viability depends on uncertain resource grades, commodity prices, and engineering feasibility.
 7. Stakeholder conflict and legitimacy. The polarised debate - companies and some states on one side, NGOs, many scientists and civil society on the other - challenges the legitimacy of ISA and pressures political decision-making.

Scientific consensus in recent years has emphasised significant uncertainties and advised a precautionary approach until more baseline data and impact modelling are available.

Governance & Control Challenges

The governance of deep-sea mining faces several structural and practical hurdles:

1. Incomplete regulatory framework. ISA exploitation regulations (Mining Code) have been under negotiation for years; in the absence of a robust, science-informed code, decisions on exploitation licensing risk being premature.
2. Scientific uncertainty and baseline data gaps. Large tracts of the deep ocean are poorly characterised biologically, chemically and geologically, complicating impact assessment and monitoring design.

Statistics & Scale

By mid-2024, dozens of exploration contracts had been granted for areas of the international seabed, spanning several million square kilometres in total, exploration covered nodules (large claims in the CCZ), sulfides (mid-ocean ridges and back-arc basins) and crusts (seamounts). No large-scale commercial exploitation was yet underway in the Area, though some states and companies were progressing technology development and national licensing in their Exclusive



Economic Zones (EEZs). Precise contract counts and claimant lists evolve with ISA activity and thus should be checked in the ISA registry for up-to-date figures.

Way Forward - Precaution, Science & Governance Reform

Given the high uncertainty and potential for irreversible harm, four pragmatic priorities emerge:

1. Adopt a precautionary posture. Delay large-scale exploitation until rigorous, peer-reviewed impact assessments, long-term monitoring frameworks, and independent baseline data exist.
2. Strengthen the ISA and transparency. Complete a robust, enforceable Mining Code that includes independent monitoring, financial assurance, adaptive management, and clearly defined benefit-sharing.
3. Scale science and open data. Fund multinational baseline programmes, standardise monitoring protocols, and require open data to inform cumulative-effects assessments.

4. Promote equitable outcomes. Design benefit-sharing and capacity-building mechanisms which respect the interests of developing states and indigenous peoples, and which fund ocean conservation and restoration.

Conclusion

Deep-sea mining stands at the crossroads. The technological possibilities for extracting mineral wealth from the seafloor are advancing, but the scientific evidence of potentially grave, long-lasting environmental impacts and the current governance gaps counsel caution. The international community's task is to reconcile the demands for critical minerals with the obligation to steward a common that supports unique, fragile ecosystems. How the ISA, states, industry and science choose to act in the coming years will determine whether deep-sea mining becomes a managed, low-impact complement to terrestrial mining or a source of irreversible ocean loss. 

Reference

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World Ocean Council: Steering Sustainable Seas

by
Chin Fong Yin

Feature



The World Ocean Council (WOC) is a global, industry-led organisation that mobilises ocean-related businesses to advance sustainable ocean management and to provide an organised private-sector voice in international ocean governance. Founded to bridge the persistent gap between industry practice and ocean policy, WOC pursues a dual mission: To encourage corporate ocean responsibility (the idea that ocean-dependent industries adopt proactive stewardship) and to ensure that industry is an engaged, constructive participant in global policy processes

shaping the ocean economy. That mission is expressed in a continuing programme of governance-oriented reports, position papers, summit outcomes, and programme documentation which together shape the influence of WOC and set a practical agenda for the private sector.

Governance Reporting & Outputs

WOC governance outputs fall into a few recurring types. First are summit and conference reports, in particular, the outcome reports of

the annual *Sustainable Ocean Summit (SOS)*. These documents synthesise discussions among CEOs, industry experts, scientists and policy makers and distil recommendations, voluntary commitments and next steps for business engagement in priority governance areas.

Second are programme reports and white papers produced under WOC initiatives (e.g. on sustainable finance, marine technology, marine spatial planning, and industry engagement with multilateral processes). These programme outputs typically summarise research, pilot projects, and policy recommendations designed to make sustainable practices actionable for companies.

Third are position statements and policy briefs which articulate the business community's perspective in major multilateral negotiations, e.g. briefs or statements on marine biodiversity beyond national jurisdiction (BBNJ), on the implementation of the UN Decade of Ocean Science, or on maritime climate adaptation and decarbonisation pathways.

Finally, WOC prepares membership and sectoral guidance documents - practical toolkits for companies (e.g. on industry best practices, data-sharing protocols, or corporate risk assessment related to ocean change).

Collectively, these governance outputs aim to do two things: To translate science and policy into operational steps which companies can adopt and to translate industry practicalities back into policy recommendations which are realistic and implementable.

Role in Ocean Governance

The central role of WOC is as a convener and translator. It convenes diverse sectors - shipping, oil & gas, fisheries, ports, aquaculture, renewable offshore energy, tourism, marine technology, and finance - around cross-cutting ocean governance issues. It acts as a bridge between private-sector capability and

public-sector rule-making. It brings operational expertise and data to international policy fora, and it amplifies multilateral policy signals back to industry through guidance and pilot initiatives.

Patterned around four strategic goals - catalyse action, amplify industry voice, build collaborative networks, and facilitate investment for sustainable ocean development - the WOC operates through thematic platforms (e.g. sustainable finance/BlueFIN, technology/Smart Ocean, innovation/BEGIN) and through targeted workstreams (e.g. shipping decarbonisation, plastics mitigation, coastal resilience). In multilateral spaces, the WOC provides industry input to the UN's ocean processes, biodiversity conventions, and regional sea conventions, seeking to ensure that industry realities inform treaty design and implementation.

Collaborative Bodies & Partnerships

The influence of WOC is multiplied by a large and diverse collaborative network which includes:

- UN entities and intergovernmental processes such as UN Environment, the Intergovernmental Oceanographic Commission (IOC/UNESCO), the UN Decade of Ocean Science, and treaty negotiations such as BBNJ where WOC seeks formal and informal engagement.
- International organisations and conventions - e.g. IMO (maritime regulation), CBD (biodiversity), IUCN and UNEP regional programmes - where WOC contributes business perspectives.
- Industry associations and corporate members such as shipping lines, port operators, offshore energy companies, fisheries companies, insurers and banks. These members are the backbone of the WOC private-sector mandate.
- Non-governmental organisations and research institutions such as academic partners, independent research groups and NGOs which co-develop projects, pilot testing, and knowledge products.

- Regional bodies and coastal authorities which are important for implementing practices at the local level.
- Financial institutions and investors through sustainable finance initiatives which tie capital flows to ocean stewardship.

These collaborations are both horizontal (across industry sectors) and vertical (from local pilots to global policy engagement), enabling WOC to knit together solutions that are technically plausible and politically relevant.

Challenges Faced in Governance & Implementation

The WOC, while strategically positioned, confronts multiple governance and operational challenges.

1. **Diverse and sometimes conflicting industry interests.** The ocean economy is highly heterogeneous. Reconciling priorities across oil & gas, shipping, aquaculture, fishing, ports, tourism and finance requires constant negotiation. What is feasible for a port operator may not be acceptable for small-scale fishers or offshore energy projects. WOC must balance competing sectoral needs while preserving an ambitious sustainability agenda.
2. **Perception and trust issues.** Industry-led advocacy can be met with scepticism by civil society and some states, particularly where past commercial practices have contributed to environmental degradation. Establishing credibility requires transparency, strong science partnerships, and demonstrable results from pilots and best-practice adoption.
3. **Capacity and resource constraints.** The work of WOC spans many issues and geographies. Running high-quality, technically robust programmes demands sustained funding and technical expertise. Mobilising sufficient resources for large-scale implementation (e.g. scaling decarbonisation in shipping or financing large ocean restoration projects) is a constant challenge.
4. **Data sharing and standards.** Effective governance relies on good data on emissions, biodiversity baselines, shipping tracks, or fisheries catch. However, companies can be reluctant to share proprietary data. WOC must foster trusted data-sharing frameworks and common standards that protect commercial confidentiality while allowing policy-relevant aggregation.
5. **Regulatory fragmentation and multilateral complexity.** Ocean governance sits across multiple interlocking regimes (IMO, CBD, regional seas, trade rules). Ensuring that industry inputs are heard and that outcomes are coherent across forums is technically and diplomatically hard.
6. **Geopolitical and equity considerations.** Developing countries and small island developing states (SIDS) have different priorities and limited capacity. Ensuring that corporate-led initiatives do not marginalise vulnerable states, and that benefits and responsibilities are allocated fairly, is essential but difficult.
7. **Scaling pilots into policy and practice.** WOC often pilots innovative approaches (e.g. industry consortia for marine protected area monitoring or blue finance products). Moving from successful pilots to industry-wide uptake or to integration into regulation remains an implementation hurdle.
8. **Managing conflicts of interest.** Because WOC depends on industry membership, it must be careful that advocacy remains aligned with public-good outcomes. Strong governance, third-party verification, and inclusive stakeholder engagement are necessary to avoid capture.

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In summary, the WOC functions as a pragmatic industry voice in global ocean governance, producing governance-relevant reports, convening cross-sector dialogues, and piloting actionable solutions.

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Looking Ahead

To overcome these challenges and deepen its governance impact, WOC can (and does) pursue several strategic paths.

- Strengthen multi-stakeholder partnerships with science and civil society.
- Prioritise transparency through published indicators and verified commitments
- Promote interoperable data standards and trusted data platforms.
- Leverage sustainable finance to de-risk sectoral transitions.
- Tailor capacity building to the needs of developing states and SIDS.

More importantly, the comparative advantage of WOC is its convening power. By creating safe spaces where CEOs, scientists and policy makers can co-design pragmatic solutions, it can accelerate shifts in corporate practice that complement and reinforce public regulation, moving ocean economy toward sustainability while keeping the private sector at the table.

Conclusion

In summary, the WOC functions as a pragmatic industry voice in global ocean governance, producing governance-relevant reports, convening cross-sector dialogues, and piloting actionable solutions. Its effectiveness depends on striking the right balance between commercial realities and environmental stewardship, building trust through transparency, and catalysing finance and technology for ocean sustainability.

The path ahead requires continued collaboration, robust data frameworks, and a commitment to equitable outcomes so that business-led leadership becomes a credible force for a healthier ocean. 🌊

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Offshore Engineering Challenges in Malaysia and Beyond

by
Mary Foo Mee Sim

Feature



Offshore engineering has become one of the most dynamic and demanding branches of engineering in the modern era. Defined as the design, construction, and maintenance of structures, systems, and technologies located in marine environments, it encompasses oil and gas platforms, renewable energy infrastructure, subsea systems, and coastal protection works.

Unlike land-based engineering, offshore projects are exposed to unique challenges such as harsh weather, saltwater corrosion, seismic risks, and logistical limitations. Moreover, offshore engineering must balance technical feasibility, environmental sustainability, and

economic viability in an era of global energy transition. This article explores the major challenges in offshore engineering across four domains: Oil and gas platforms, renewable energy installations, subsea engineering, and coastal protection works, with insights into technological innovation, environmental management, and policy frameworks.

Oil & Gas Platforms: Complex Systems in Harsh Seas

Oil and gas extraction has traditionally dominated offshore engineering. Platforms such as fixed structures, compliant towers,

semi-submersibles, tension leg platforms (TLPs), and Floating Production Storage and Offloading (FPSO) units are deployed globally in regions like the North Sea, the Gulf of Mexico, and South-East Asia. As each type of structure addresses different water depths and geological conditions, engineering design must adapt to site-specific challenges.

One of the greatest challenges lies in structural stability. Fixed platforms resting on steel or concrete legs, are cost-effective in shallow waters but become uneconomical beyond depths of 500m. For deeper fields, floating platforms such as TLPs and semi-submersibles are used, requiring sophisticated mooring systems to maintain stability against waves, currents, and storms. The challenge here is to ensure these structures remain safe under extreme environmental loads, including hurricanes and rogue waves which may exceed conventional design expectations.

Safety is another major concern. Offshore oil and gas operations involve flammable hydrocarbons under high pressures and temperatures, raising risks of blowouts, explosions, and fires. Incidents such as the Piper Alpha disaster in 1988 and the Deepwater Horizon spill in 2010 revealed the catastrophic consequences of design failures, inadequate safety culture, or human error. Engineering solutions such as blowout preventers, fire suppression systems, and remote monitoring technologies have since been enhanced, but ensuring absolute safety in unpredictable conditions remains elusive.

Environmental sustainability compounds these challenges. Offshore drilling and production risk oil spills, marine pollution, and greenhouse gas emissions. Engineering has responded with technologies such as subsea separation, produced-water reinjection, and carbon capture and storage (CCS) to reduce ecological footprints. However, the industry still faces pressure from international regulations and public opinion to transition toward cleaner alternatives, making long-term investment in offshore oil and gas increasingly complex.

Renewable Energy: Harnessing Wind, Waves & Tides

The global push toward decarbonisation has placed offshore renewable energy at the forefront of engineering innovation. Offshore wind farms, wave energy converters, and tidal turbines offer significant potential to supply low-carbon electricity. Of these, offshore wind has seen the most rapid growth, particularly in Europe, China, and the United States.

Engineering challenges arise primarily in installation, operation, and maintenance. Offshore wind turbines must withstand high winds, wave action, and seabed scouring while delivering stable power to onshore grids. Foundation types such as monopiles, jackets, gravity bases, and floating platforms are selected based on water depth and seabed conditions. In deeper waters exceeding 60m, floating wind platforms have become essential, but these require advanced mooring and dynamic cabling systems, introducing new technical uncertainties.

Grid integration presents another challenge. Offshore wind farms are often located tens or hundreds of kilometres from shore, necessitating subsea power transmission via high-voltage alternating current (HVAC) or direct current (HVDC) cables. Designing cables which can withstand thermal stress, bending fatigue, and saltwater exposure is a persistent challenge.



Furthermore, the variability of wind and wave resources requires smart grid solutions, energy storage, and hybrid systems to ensure reliability.

Operation and maintenance (O&M) costs are particularly high for offshore renewables due to their remote locations. Accessing turbines for repair often requires specialised vessels, helicopters, or autonomous drones, especially in rough weather. As the industry scales, innovations such as predictive maintenance using artificial intelligence, remotely operated vehicles (ROVs), and self-healing materials are being developed to reduce costs.

Environmental considerations also come into play. While renewables reduce carbon emissions, offshore wind farms may disrupt marine habitats, bird migration routes, and fisheries. Engineering solutions such as quieter pile-driving techniques, fish-friendly turbine designs, and biodiversity monitoring systems are being explored to minimise impacts.

Subsea Engineering: Hidden Backbone of Offshore Systems

Subsea engineering underpins both oil and gas and renewable energy systems, comprising pipelines, risers, manifolds, and control systems installed on the seabed. These assets must operate reliably under extreme pressures, low temperatures, and corrosive seawater conditions, often at depths beyond 2,000m.

Pipeline design exemplifies the complexity of subsea engineering. Pipelines must withstand internal pressures from transported fluids and external pressures from deep water while resisting corrosion and fatigue. Thermal insulation is crucial to prevent hydrate and wax formation in oil pipelines, which can block flow. Engineering innovations include pipe-in-pipe insulation, flexible flowlines, and subsea heating systems to ensure continuous flow assurance.

Another critical challenge lies in subsea intervention and repair. Unlike onshore pipelines, subsea assets are difficult to access, requiring ROVs

or autonomous underwater vehicles (AUVs) to carry out inspection and maintenance. Developing cost-effective intervention strategies is vital to extend asset life and reduce downtime. Digital twin technology, which creates virtual replicas of subsea systems, is increasingly used to simulate performance and optimise operations.

Subsea control systems further highlight engineering complexity. Umbilicals deliver power, chemicals, and communication signals to subsea equipment, and must operate reliably over decades despite constant exposure to seawater and mechanical stress. Failures in control systems can halt entire production facilities, making redundancy and reliability essential in design.

Coastal Protection Works: Engineering vs Nature

Beyond energy and subsea systems, offshore engineering also encompasses coastal protection. With rising sea levels and intensifying storms linked to climate change, coastal cities and communities face increasing risks of flooding, erosion, and storm surges. Engineering solutions such as seawalls, breakwaters, revetments, and artificial reefs are deployed to safeguard coastlines and infrastructure.

Design challenges stem from balancing effectiveness, cost, and environmental impact. Seawalls and breakwaters provide immediate protection but may cause ecological damage and alter sediment transport, leading to unintended erosion elsewhere. “Soft engineering” approaches such as beach nourishment, mangrove restoration, and living shorelines are increasingly favoured, though they require continuous maintenance.

Case studies such as the Dutch Delta Works and Japan’s coastal defences after the 2011 Tōhoku earthquake and tsunami, highlight the importance of engineering foresight and adaptability. These projects combine hard and soft measures, advanced modelling, and robust governance to achieve long-term resilience.

For Malaysia and other South-East Asian nations, coastal protection is of particular urgency due to extensive coastlines, dense coastal populations, and reliance on port infrastructure. Engineering must adapt to tropical conditions, monsoon-driven erosion, and ecological sensitivities in mangrove ecosystems.

Integrating Technology, Sustainability & Policy

A unifying theme across offshore engineering is the need to integrate technology, sustainability, and policy. Digital technologies such as artificial intelligence, machine learning, and digital twins are revolutionising design and maintenance by enabling predictive analytics and real-time monitoring. Advanced materials, including corrosion-resistant alloys, composites, and self-healing coatings, are extending the lifespan of offshore structures.

Sustainability is no longer optional. International frameworks such as the United Nations Convention on the Law of the Sea (UNCLOS), the International Maritime Organisation (IMO) regulations, and regional agreements require offshore projects to minimise environmental harm. Engineering must therefore consider ecological impacts at every stage, from site selection and construction to decommissioning. For example, the concept of circular economy in offshore engineering promotes the reuse of materials, repurposing of decommissioned platforms as artificial reefs, and recycling of subsea infrastructure.

Policy also plays a decisive role. Governments and regulatory bodies set safety standards, environmental regulations, and incentives for renewable energy. For instance, the European Union's Green Deal and the U.S. Inflation Reduction Act have spurred rapid investment in offshore wind, while regions dependent on oil and gas, such as the Middle East, face complex policy choices about balancing energy security with transition goals.

Conclusion

Offshore engineering stands at the crossroads of energy, environment, and innovation. Oil and gas platforms continue to push technological frontiers in deep and ultra-deep waters, even as environmental and safety concerns intensify. Offshore renewables, especially wind energy, promise cleaner alternatives but face challenges such as cost, maintenance, and ecological integration. Subsea systems remain the hidden backbone of offshore industries, requiring advanced materials, robotics, and digital technologies to operate reliably under extreme conditions. Coastal protection, meanwhile, underscores the critical role of engineering in safeguarding human settlements against climate change.

The challenges in offshore engineering are multifaceted and evolving. They demand not only technical expertise but also interdisciplinary collaboration across environmental science, policy, and economics. As nations worldwide navigate the energy transition, offshore engineering will remain pivotal in shaping a sustainable and resilient future. By embracing innovation, adhering to rigorous safety standards, and prioritising environmental stewardship, offshore engineers will be able to rise to the challenge of building in the most hostile yet vital frontier on Earth - the sea. 🌊

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Engineering Sustainable Business: Integrating Carbon Strategy and Waste Management for a Greener Malaysia

by
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Izzal Ismail,
ChM. Dr. Norshidah
Baharuddin,
Gooi Chye Seong

SIRIM Berhad

The global economic landscape is undergoing a profound transformation, with environmental sustainability emerging as a critical driver of business success and national resilience. For Malaysian businesses, the call to “go green” is no longer merely an ethical consideration but a strategic imperative. At the forefront of this shift, SIRIM is actively paving the path towards a sustainable future by empowering organisations with comprehensive solutions, from accurately measuring their carbon footprint to integrating robust Environmental, Social, and Governance (ESG) practices into their core operations.

The inextricable link between the health of our environment and the vitality of our economy cannot be overstated. Our industrial ecosystem fundamentally relies on natural resources, transforming them into marketable and value-added products and services. Consequently, a stable and healthy environment forms the bedrock of a thriving economy. This undeniable truth has spurred a growing demand for a more stringent regulatory framework, both nationally and internationally, to safeguard our precious environmental assets.

This significant evolution necessitates a more comprehensive and engineering-driven approach to environmental management.

Environmental performance must be managed inclusively, encompassing not only direct operational activities but also indirect impacts across multi-tiered value chains, from upstream raw material extraction to downstream waste management and disposal. Neglecting the environmental impact of a business is no longer a viable option; adverse environmental performance carries substantial financial and reputational risks, with potential global repercussions. Indeed, investing in environmental accountability beyond mere compliance is key to maximising growth, mitigating risks, and creating efficiencies for businesses and the nation. In this regard, enhancing operational efficiencies, reducing resource consumption, and minimising waste generation and emissions to air, water, and land are crucial steps towards achieving environmental sustainability and, ultimately, holistic economic growth.

Engineering Accountability: Calculating Carbon Footprints

For engineers and business leaders alike, evaluating environmental performance is paramount to upholding their roles as responsible stewards of the environment.

A crucial tool in this evaluation is the measurement of carbon emission intensity. For many forward-looking businesses, this initial measurement serves as a vital checkpoint, enabling them to predict performance, proactively intervene to mitigate potential environmental risks, and establish a clear sense of accountability. Armed with this data, organisations can then formulate targeted reduction plans, implement innovative initiatives, and advance their decarbonisation strategies.

A comprehensive decarbonisation strategy takes into consideration and consolidates all key elements of the net zero planning process. It provides a high-level framework that guides an organisation's actions regarding carbon emissions and management, driving efficiency and innovation.

Understanding the carbon footprint at both the corporate and product levels is instrumental for informed decision-making. This quantifiable data helps businesses identify their own operational emissions, pinpoint upstream and downstream environmental impacts, prioritise areas for improvement, as well as measure and track achievements. Critically, it allows for the reduction of costs and environmental impacts throughout their operations and value chains, often revealing opportunities for process optimisation and waste reduction.

For the robust quantification of carbon emissions, internationally recognised ISO standards provide invaluable guidelines. While ISO standards offer overarching principles and requirements applicable across various users, the step-by-step quantification process is typically detailed in specific guidance documents developed under the ISO umbrella.

A widely adopted and respected guidance document for carbon quantification is the Greenhouse Gas (GHG) Protocol standards. It is important to differentiate that while the term "carbon footprint" can refer to both product and organisational level carbon emissions, ISO 14067 is utilised for product-specific assessments, while ISO 14064-1 governs organisational level carbon measurements.

The E Pillar: A Multi-Pronged Engineering Approach

Upholding the ESG "environmental pillar" demands a multi-pronged approach rooted in sound engineering principles. As environmental sustainability increasingly influences investors and customers, businesses must strategically focus on building a sustainable brand alongside their products and services.

Industry players are compelled to assess business operations to not only comply with but also to proactively surpass current market and regulatory requirements. This also necessitates enhanced engagement with both upstream and downstream value chains to facilitate collective efforts in achieving environmental goals. To address this, businesses must first comprehensively understand their environmental impact and adapt accordingly. It is crucial to define tangible climate actions; organisations which fail to articulate their climate strategies, risk damaging their reputation and hindering business growth.

With awareness comes action. Businesses can begin to transform their operations to prioritise environmental sustainability. By committing to specific areas for eco-improvements, they can systematically enhance the environmental sustainability performance of their brand, products, and services.

Effective communication is paramount to understanding and propagating climate-action based initiatives. Engineers and industry leaders must actively collaborate with their supply chains to ensure alignment towards specific environmental objectives. This holistic approach not only attracts new customers and investors but also secures long-term business success.

Carbon Value: Performance Indicator for Eco-Efficiency

Quantified carbon emissions provide a powerful metric for assessing operational eco-efficiency. By extrapolating these results

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The initial step for any industry player seeking to reduce carbon emissions is to identify emission sources within its business operations and to prioritise actions to tackle key carbon intensity contributors.

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to gauge productivity or efficiency ratios and carbon intensity ratios, businesses gain valuable insights for strategic decision-making. A productivity/efficiency ratio, measured by business achievement against the resultant carbon impact, indicates positive performance improvement with an increase. Conversely, a carbon intensity ratio, measured by carbon impact per unit of physical or economic output, signifies negative environmental performance when it increases.

An important factor for industry players to consider is their current business activities in terms of energy intensity. Both energy intensity and carbon intensity are inextricably linked indicators. In fact, metrics based on energy and carbon intensity offer profound insights for business decision-making. By leveraging these metrics, businesses can obtain a clear indication of their operational efficiencies from an environmental perspective. This allows organisations to evaluate total measured carbon emissions against total units of production or total economic activity, thereby enabling more effective alignment of carbon emission reduction initiatives and decarbonisation strategies with their economic growth.

The initial step for any industry player seeking to reduce carbon emissions is to identify emission sources within its business operations and to prioritise actions to tackle key carbon intensity contributors. This can encompass replacing fossil-based energy sources with renewable alternatives such as biomass, solar, wind, and hydropower. Crucially, it also involves implementing robust waste reduction, reuse, and recycling programmes, recognising that waste generation, transport, and disposal contribute significantly to a company's overall carbon footprint. Ultimately, a steadfast commitment to sustainability and environmental goals can attract new customers and investors while simultaneously driving robust economic growth.

Propagating ESG Commitments through SIRIM 's Integrated Services

As one of the technology centres under SIRIM Industrial Research (SIRIM IR), the Energy & Environment Centre (EEC) plays an instrumental role in propelling the adoption of ESG practices in Malaysian industries. SIRIM's comprehensive suite of services extends beyond environmental

measurement to encompass structured management systems and transparent reporting frameworks, covering the full spectrum of ESG needs.

EEC's expert services that help organisations evaluate and manage their environmental impact include:

- **Eco-material product supports and solutions:** Assists companies in developing sustainable materials and products that meet growing environmental demands.
- **Environmental laboratory testing:** Provides accurate and reliable data for environmental assessments.
- **Technical environmental performance evaluation which uses:**
 - o Single Multiple environmental impact or ecological footprint analysis through Life-Cycle Assessment (LCA) (ISO 14044).
 - o Single environmental impact assessment through Product Carbon Footprint (CFP) analysis (ISO 14067).
 - o GHG emission accounting for organisational level measurement (ISO 14064-1).

Beyond these technical evaluation services, SIRIM offers critical frameworks to operationalise and communicate ESG commitments.

ESG Management System Certification (SIRIM 55:2023)

A pioneering management system, SIRIM 55:2023 provides companies with a structured framework to help integrate ESG practices into their operations seamlessly, thereby enhancing their overall sustainability profile. By adopting this certification, businesses can ensure compliance with evolving regulatory requirements while simultaneously improving operational efficiency, reducing risks, and fostering long-term growth.

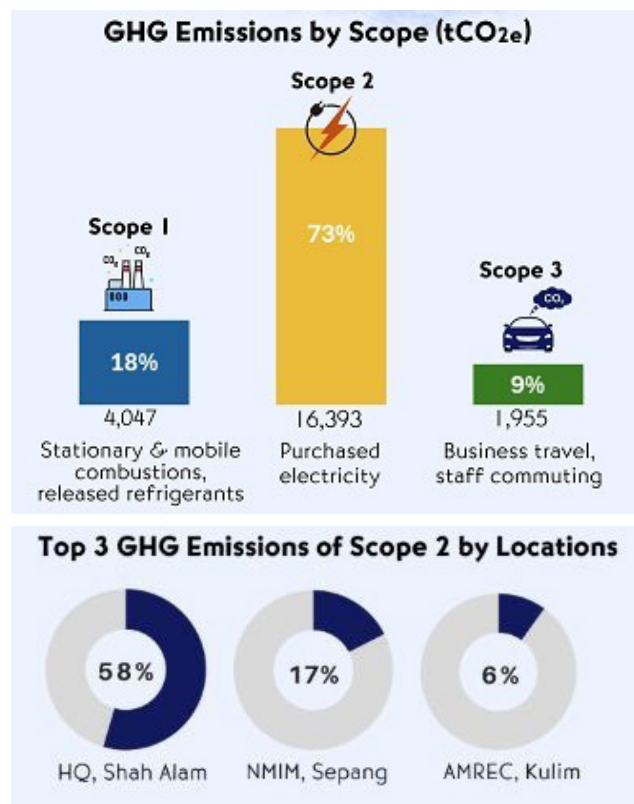
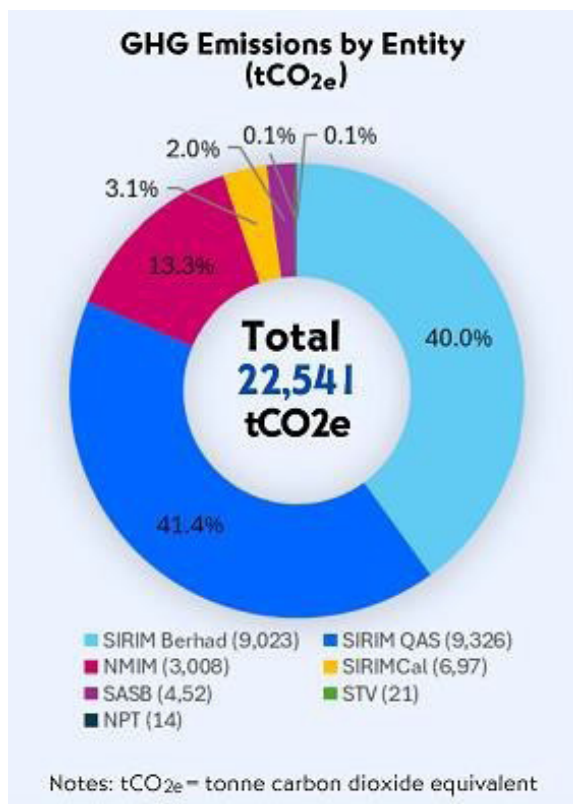
Certified companies stand to benefit from better corporate governance practices, stronger relationships with stakeholders, and improved market competitiveness, as an increasing number of investors and customers prioritise sustainability. This initiative promises enhanced stakeholder confidence, improved reputation, and increased access to green funding and investments, underscoring SIRIM's unwavering commitment to advancing sustainability and responsible business practices across Malaysia.

ESG Reporting Framework (SIRIM 56:2024)

While implementing ESG principles is undoubtedly important, these efforts must also be visible and transparent to stakeholders. SIRIM's ESG reporting framework, specifically SIRIM 56:2024, effectively addresses this crucial aspect. Catering especially to Small & Medium-sized Enterprises (SMEs), this service provides a streamlined approach to track, manage, and report ESG efforts. By following the SIRIM 56:2024 framework, SMEs can significantly enhance their ESG reporting quality, build trust with stakeholders, and demonstrate their commitment to sustainable and responsible business practices, aligning with both industry best practices and regulatory expectations. This service empowers companies to clearly communicate their ESG strategies to stakeholders, reinforcing their dedication to transparency and responsible business practices.

SIRIM as a Case Study: Leading by Example

SIRIM serves as a tangible case study, demonstrating its commitment to environmental accountability. The SIRIM GHG accounting for 2023, encompassing all SIRIM business entities operating in Malaysia and China from 1 January to 31 December 2023, was conducted using the rigorous methodologies of ISO 14064 - Part 1, the GHG Protocol for a Corporate Accounting and Reporting Standard, and the 2006 Intergovernmental Panel on Climate Change (IPCC) Guidelines.



The findings revealed that total emissions were:

- **73% from Scope 2 (purchased electricity)**, amounting to 16,393 tCO_{2e}, highlighting the importance of energy efficiency and renewable energy adoption. The top contributors in Scope 2, by location, were HQ Shah Alam (58%), NMIM Sepang (17%), and AMREC Kulim (6%).
- **18% from Scope 3 (indirect emissions)**, totalling 1,955 tCO_{2e}, primarily from business travel and staff commuting. This scope also implicitly includes emissions from waste generated by operations, further emphasising the need for robust waste reduction strategies.
- **9% from Scope 1 (direct emissions)**, accounting for 4,047 tCO_{2e}, primarily from stationary and mobile combustions and released refrigerants.

These comprehensive data points establish a crucial baseline, which will be continuously monitored to track and drive emissions reduction initiatives across SIRIM.

The technical services offered by EEC, complemented by SIRIM 55 and SIRIM 56, empower companies to assess their environmental impact thoroughly and to identify actionable opportunities for improvement. By pinpointing areas for reducing their environmental footprint, organisations can make more informed decisions that align seamlessly with ESG principles. EEC's expertise in eco-material development further supports companies in creating sustainable products, meeting the escalating market demand for environmentally friendly solutions.

With its expertise in technical evaluation, certification, and consultancy, SIRIM plays a vital role in promoting the uptake of ESG practices, enabling organisations to effectively manage their environmental impact, and facilitating the development of sustainable

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All industry players must commit to conducting rigorous environmental assessments and adopting comprehensive ESG frameworks.

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solutions for a greener economy. EEC's service offerings are specifically designed to promote and support environmental sustainability initiatives among industries and organisations in the country. This is evident in its collaborative projects with various companies on product carbon footprinting and corporate-level GHG emission accounting, working with Malaysian manufacturing companies from diverse industrial sectors including metal, additives, and oleo-chemical industries.

Furthermore, SIRIM, through EEC, is a key implementing agency in the international Collaborative Action on Prevention of Single-use Plastic in South-East Asia (CAPSEA) initiative, a testament to its commitment to addressing critical environmental challenges. Funded by the German Federal Ministry for the Environment, Nature Conservation, Nuclear Safety & Consumer Protection (BMUV) and coordinated by Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), with oversight from the Malaysian Ministry of Economy, this project directly links to waste management. Outputs from CAPSEA include findings and recommendations pertaining to the stimulation of the plastic recycling market via circular economy policy support and

improving the design of products and services through an eco-design policy framework, crucial elements for reducing waste and carbon emissions.

Promoting environmental sustainability initiatives is not merely an option but a crucial imperative for the growth and enduring success of Malaysian businesses, ensuring they remain competitive and relevant in an increasingly environmentally conscious global market.

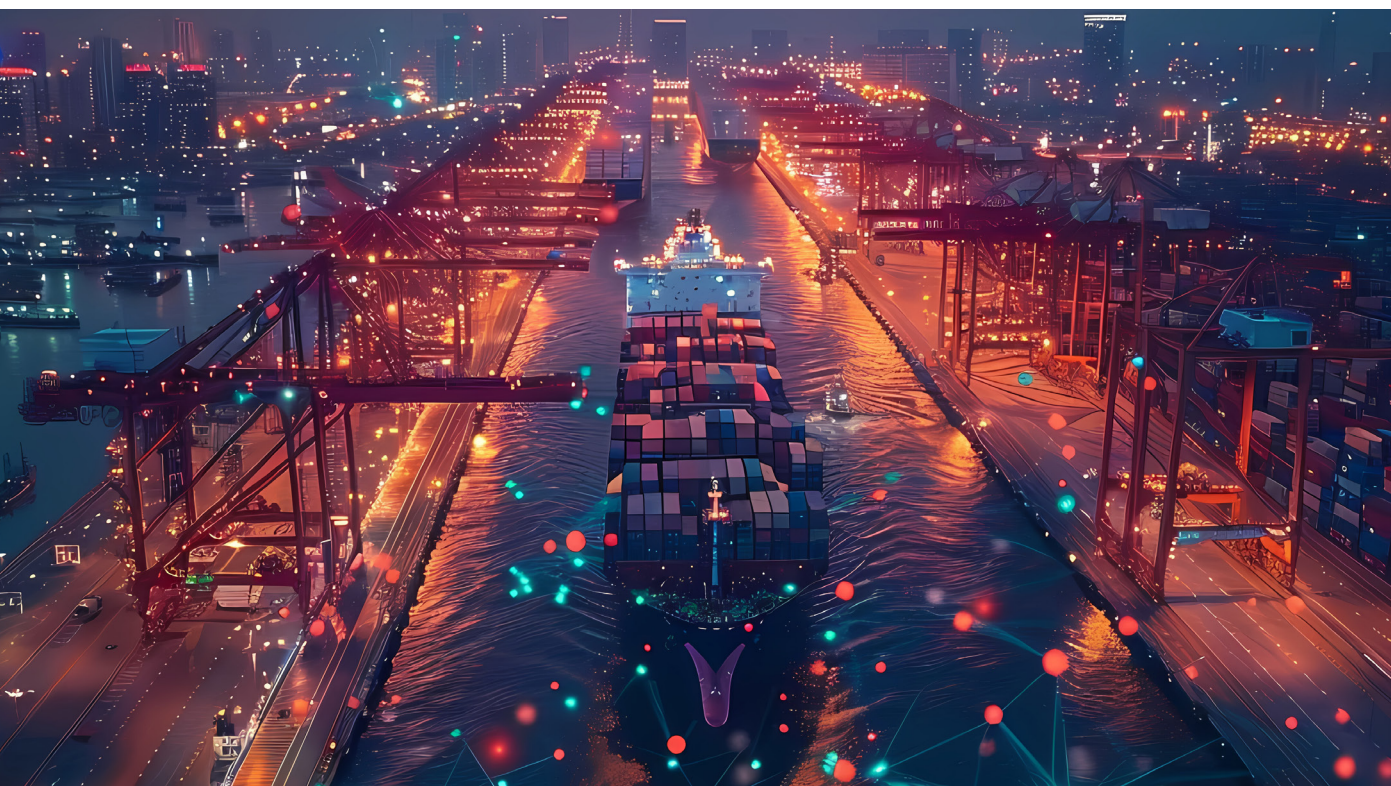
Moving Forward

All industry players must commit to conducting rigorous environmental assessments and adopting comprehensive ESG frameworks. This fundamental first step provides the baseline measurement of carbon emissions and operational integrity, allowing organisations to embark on a quantifiable progress path towards reducing their carbon footprint and contributing to Malaysia's ambitious targets of reducing Nationally Determined Contributions (NDCs) by 45% in 2030 and achieving net zero emissions by 2050. The engineering community has a pivotal role to play in designing and implementing these sustainable solutions for the future. 🌱

Artificial Intelligence in Shipping Industry: Transforming Maritime Operations

by
Ong Em Nee

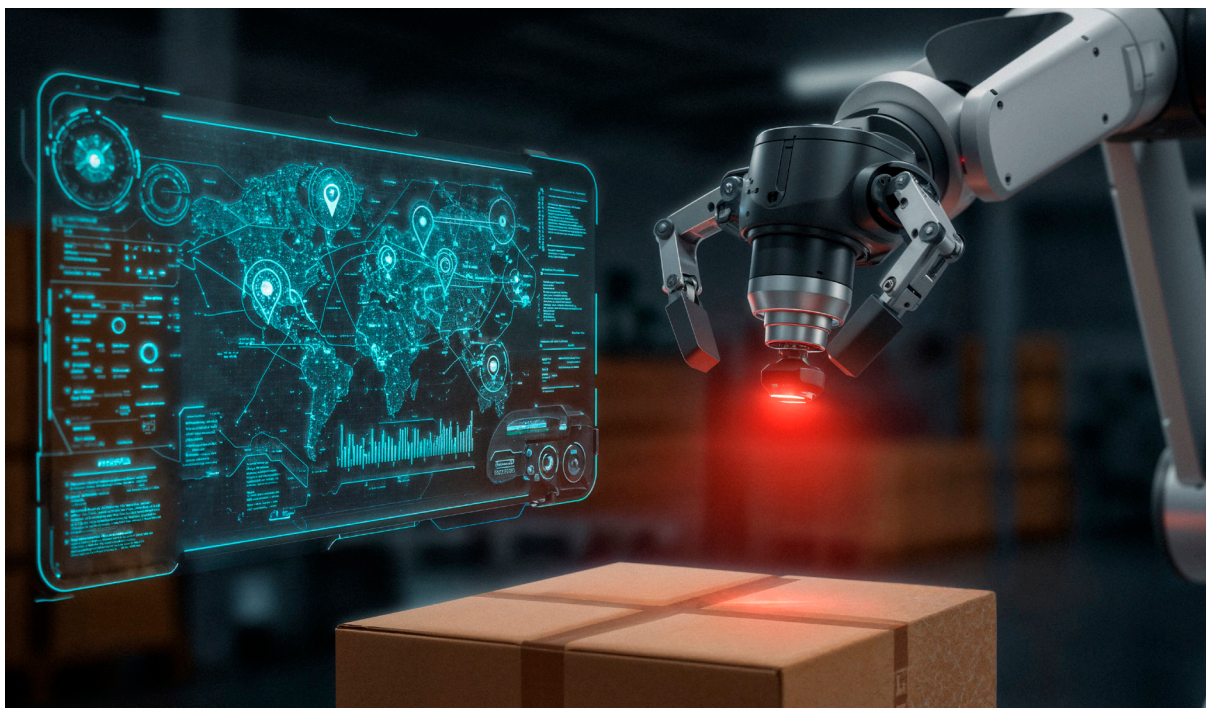
Feature



Responsible for over 90% of global trade, the maritime shipping industry now stands at the cusp of profound technological transformation. Artificial Intelligence (AI) is central to this shift, enabling smarter navigation, predictive maintenance, and port automation. For maritime nations such as Malaysia, where ports handle a vast majority of its trade (~98%) and rank highly in global throughput and efficiency, AI offers both strategic opportunity and economic imperative.

AI in Vessel Navigation & Route Optimisation

AI-driven navigation systems improve real-time decision-making by integrating weather, ocean currents, and maritime traffic data to optimise routes and fuel use. Orca AI's study found that AI-assisted voyages can reduce route deviations, save approximately US\$100,000 in fuel per vessel, and cumulatively cut global CO₂ emissions by 47 million tonnes annually.



Beyond cost and environmental gains, autonomous navigation systems contribute to enhanced safety. Maritime Collision Avoidance Systems (MCAS), leveraging AI and multiple sensor inputs (radar, AIS, sonar, etc.), now issue real-time alerts and actively predict collision risks.

Predictive Maintenance

Traditional reactive maintenance is being supplanted by AI-enabled predictive maintenance systems. These systems use smart sensors and machine learning models to monitor engine and equipment health, allowing for preemptive interventions and condition-based scheduling. The benefits are clear: Reduced unplanned downtime, lower operational costs, improved safety, and higher vessel availability. Industry-wide data suggests AI-driven predictive maintenance can cut downtime by up to 30%. However, integrating Explainable AI (XAI) into maintenance systems may be essential to boost user trust and interpretability.

Smart Ports & Terminal Automation

AI is redefining port operations through intelligent berth allocation, automated crane control, and digital twins which simulate and optimise terminal workflows. Malaysia is making notable strides at Westports (Port Klang), Port Dickson and Johor Port. These developments have enabled the country to evolve into a leading AI-powered maritime hub in South-East Asia.

AI in Supply Chain & Logistics

AI enhances maritime logistics by enabling demand forecasting, dynamic scheduling, freight cost optimisation, and end-to-end visibility. Its use in e-logistics platforms improves matching of shippers and carriers, reducing empty container movements and increasing efficiency. Globally, freight optimisation platforms such as Good Ship highlight the potential of AI by using shipping network analytics to prevent overpayment, flag inefficiencies, and guide procurement decisions.

Safety & Compliance

Maritime safety is increasingly managed through AI-powered systems: Early hazard detection, real-time alerts for engine overheating or unauthorised access, and regulatory compliance monitoring (e.g., MARPOL, SEEMP frameworks) enhance safety outcomes and regulatory adherence. Additionally, Orca AI's findings suggest AI's dual role in reducing environmental impact while improving navigational safety.

Crew Welfare & Scheduling

AI systems improve crew welfare through fatigue monitoring, optimised rotations, and mental health tracking via wearables and behavioural analytics. Reducing stress and preventing burnout among seafarers help retain skilled personnel and improve safety. Maritime academies can play a pivotal role by incorporating AI training into the curricula for future graduates.

Environmental Monitoring & Sustainability

Environmental regulation and sustainability objectives are more effectively managed with AI. Tools monitor CO₂, NO_x, and SO_x emissions in real time, and AI-optimised routing systems reduce fuel consumption, aligning with IMO's GHG reduction goals. Malaysia's alignment with green policies like the National Energy Transition Roadmap (NETR) opens opportunities for integrating AI-driven environmental monitoring at ports in Kuantan and Bintulu.

Autonomous Shipping: The Emerging Frontier

Autonomous maritime vessels are rapidly evolving from concept to reality. Hyundai Glovis, in partnership with Avikus, plans to retrofit seven pure car and truck carriers with Level-2 autonomous systems by mid-2026, including the nearly 230m-long Sunrise, which could become the largest AI-enabled ship to date.



Projections estimate that autonomous ships may account for 10% of the global fleet by 2030, with transformative impacts on vessel design, operations, and cost structures. The shift promises lower human-related accident risks, which historically account for a large proportion of maritime incidents. Yet, effective integration relies on evolving regulatory frameworks. An incremental approach, from pilot projects in controlled environments to full-scale deployment, is advised to ensure safety, secure certification, and to build resilience against cyber and operational risks.

“Malaysia, with its strategic geography and evolving port infrastructure, stands to benefit significantly.”

Challenges of AI Adoption

Despite its promise, AI adoption in shipping is not without critical challenges:

- **Cybersecurity Risks:** Increased connectivity and reliance on AI systems expose ports and vessels to cyber threats.
- **Legacy System Integration:** Older infrastructure and vessels can make AI implementation complex and costly.
- **Skill Gaps:** There is a pressing need for AI literacy among maritime professionals.
- **Regulatory Uncertainty:** International frameworks, including the IMO's MASS guidelines, are still evolving.
- **High Capital Costs:** Investments in AI-enabled ports and autonomous systems require significant capital and long-term vision.

Addressing these challenges requires coordination between government agencies, industry stakeholders, and academia.

Strategic Opportunities for Malaysia

Malaysia is well-positioned to emerge as a leading maritime AI hub through Smart Port Development, R&D for Smart Shipping through collaborations between institutions and maritime tech firms to pilot autonomous and AI solutions, digital talent pipeline, regulatory readiness and sustainability leadership.

Conclusion

Artificial Intelligence is already reshaping the shipping industry, unlocking efficiencies in navigation, maintenance, logistics, safety, and environmental performance. Malaysia, with its strategic geography and evolving port infrastructure, stands to benefit significantly. From the establishment of its first AI-powered container port to pilots in autonomous vessel integration, its maritime strategy must be to embrace AI to remain competitive, sustainable, and secure in the decades ahead. 

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Renaissance of Bicycles in Beijing Cityscape

by
Choong Yuxun



Beijing, once known as the City of Bicycles, is witnessing a remarkable resurgence in two-wheeled transportation. I was amazed to see scores of bicycles lined up along service roads as I moved around the city.

In contrast to what I had read in the media about the technologically advanced smart city of Beijing, I was instead, drawn to the multifaceted return of bicycle culture to China's capital, examining technological innovations such as QR code-based rental systems, the economic mechanisms driving widespread adoption, and the social and infrastructural factors contributing to this sustainable mobility revolution.

From crowded hutongs to modern bicycle lanes, Beijing's streets are once again alive with the hum of bicycle tyres, blending tradition with cutting-edge technology to solve contemporary urban challenges.

Beijing's relationship with the bicycle has undergone a dramatic evolution. In the 1980s, over 60% of urban trips in China's cities were made by bicycle, earning China its iconic symbol as a nation of bicycles. The simple, affordable bicycle became the most popular vehicle model in human history, with more than half a billion units deployed across China.

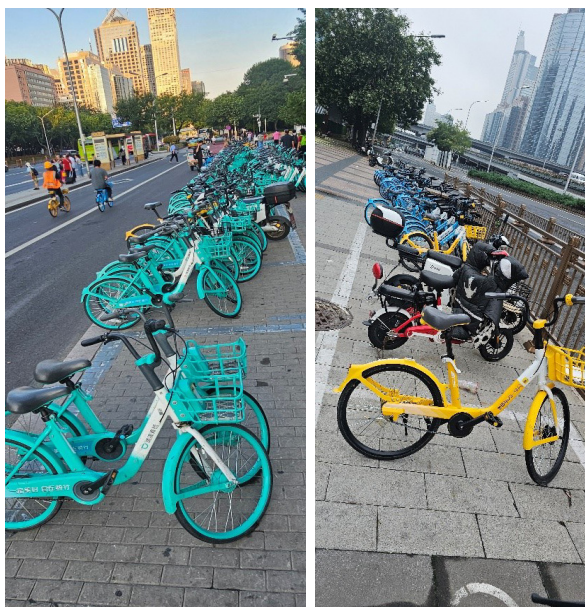


Photo 1: Bicycles and motorcycles are common in the service roads of Beijing.

However, the 1990s saw its steady decline as economic growth and Western influences made car ownership a status symbol. By 2012, the use of bicycles in urban transportation plummeted to just 16%, replaced by congested roads choked with emissions-spewing vehicles. Then the tide began to turn in the mid-2010s with the advent of dockless bike-sharing systems while the COVID-19 pandemic accelerated this shift as people sought open-air transportation options.

Today, bicycles account for approximately 30% of all urban travel in China, with Beijing at the forefront of this renaissance. The city now boasts of having 500,000 shared bikes in operation while annual cycling trips (including shared bikes) have skyrocketed from 50 million in 2017 to 950 million in 2021. This remarkable rebound represents not just a transportation trend but a cultural reawakening to the role of the bicycle in urban life.

At the heart of Beijing's bicycle resurgence was an ingenious technological solution: The QR code-based rental system. This innovation removed traditional barriers to bicycle access, creating a flexible form of "public transit" operated through public-private partnerships.

The simplicity of the system belies its transformative power as follow:

1. **App-Based Access.** Users download apps such as Meituan (yellow bikes), Hello Bike (blue), or DiDi Bike (green). These platforms support multiple languages and accept international registrations with passport verification, making them also accessible to foreign visitors.
2. **QR Code Unlocking.** Each bicycle has a unique QR code on its frame or under the saddle. Scanning this code with the apps camera (with Bluetooth assistance for precision) instantly releases the lock. Early systems like Ofo used even simpler combination locks revealed through QR scanning.
3. **Convenient payment system.** Rides conclude by manually locking the bike, automatically triggering payment through integrated platforms like Alipay or WeChat Pay, which support international credit cards since 2023. The entire process eliminates physical stations, cash transactions, or membership cards.



Photo 2: The QR code is a convenient way for users who log in to unlock the bicycle and log out upon arrival. The system will then compute the charges.



Photo 3: Users scan the QR code to lock or unlock the bicycles.

- Hello Bike: CNY1.5 per 15 minutes
- Meituan Bike: CNY1.5 for first 15 minutes + CNY1.5 every additional 30 minutes

Subscription Plans

- DiDi Bike: 7-day card (CNY10), Month card (CNY25), Season card (CNY75)
- Hello Bike/Meituan: 7-day (CNY10), Month (CNY35), Season (CNY90)

Such affordable rates, from as low as \$0.15 per hour, undercut Beijing's subway minimum fare of CNY3 (\$0.50) while offering greater flexibility.

The market consolidated around three major players after an initial frenzy that saw 77 companies operate 23 million shared bikes nationwide by 2019. This competition drove innovation, from Mobike's durable shaft-drive designs to Ofo's ultra-cheap ¥30 (US\$4) bikes, ultimately benefitting consumers through improved services and competitive pricing.

The dockless model represented a significant evolution from earlier bike-sharing systems which required fixed kiosks costing about US\$5,000 per bicycle to install. By transforming the technology from infrastructure to individual bikes via GPS and mobile connectivity, Chinese companies reduced costs while increasing flexibility. The economic implications were profound. Where traditional systems might take three years for municipal approval, Beijing's dockless bikes proliferated rapidly through private initiative.

Under the Rental Economy's Pricing Models & Market Dynamics, Beijing's bike-sharing ecosystem thrives on competitive pricing strategies tailored to different user needs such as:

Pay-As-You-Go Models

- DiDi Bike: CNY1.5 (~US\$0.20) for first 15 minutes + CNY1.5 per extra 30 minutes.



Photo 4: vendor transporting and loading the bicycles



Photo 5: The recent scene of Beijing demonstrates uses of bicycle as a permanent and complementary mode of urban mobility. Bicycles serve as a convenient, sustainable and flexible mode of transport will remain significant in future urban landscape. It offers unmatched advantages for short-haul trips and last-mile connectivity, efficiently bridging the gap between MRT stations and final destinations - areas often beyond the direct reach of public transport.

Key Factors Driving the Resurgence of Bicycles in Beijing

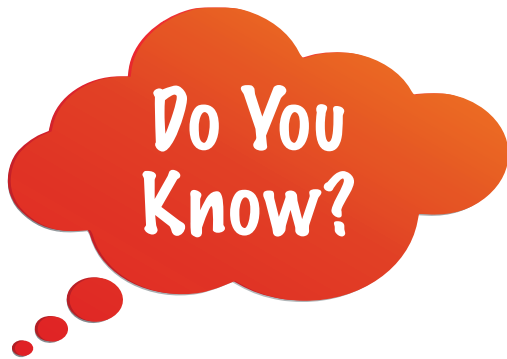
1. Urban Congestion Solutions. With subway lines requiring 30-minute queues during rush hours and Didi (China's Uber) stuck in traffic, bikes became the fastest option for 3-5km trips. Office workers use bicycles to access hutong snack shops which are impractical by car or subway. The last-kilometre connectivity between transit hubs and final destinations proved particularly valuable.
2. Beijing has aggressively expanded cycling infrastructure, including:
 - 6.5km elevated bike-only lanes between Huilongguan and Shangdi tech hubs.
 - 730.8km of themed cycling routes connecting tourist sites.
 - Widening Second Ring Road bike lanes from 2m to 3m, increasing traffic efficiency by 25% while reducing accidents.
 - Plans for dedicated bike lanes on all roads $\geq 12\text{m}$ wide within the Fifth Ring Road by 2026.
3. With transportation generating 240,000 fewer tons of CO₂ annually due to using bicycles as a mode of travel, Beijing's policies

align with national low carbon travel goals in the 14th Five-Year Plan. Shared bikes alone reportedly reduce emissions by 890,000 tons nationwide.

4. The technological convenience of utilising the simplicity of the QR code system - no deposits, stations, or cash - lowered barriers to entry. As one user noted, shared bikes eliminated worries about parking, maintenance, theft, and vandalism that had deterred private bike ownership.

For the way forward, Beijing's plan seems to cement the use of bicycles through continued infrastructure expansion and policy support. The Institute for Transportation & Development Policy noted that realising the full potential of bicycling will require designing streets and neighbourhoods that put the needs of the people first.

With its blend of cutting-edge technology and nostalgic appeal, Beijing's bicycle renaissance offers a model for sustainable urban mobility worldwide. Indeed, even in the age of autonomous vehicles and hyperloops, sometimes the simplest solutions roll smoothest on two wheels. 🚲



Construction Industry

by

Cheo Hong Keyong

Why the construction industry must climb out of its productivity rut - Mckinsey.

When it comes to creating a more sustainable future, the construction industry has a big role to play. On top of fulfilling critical economic and societal needs for offices, housing, hospitals, and infrastructure, the industry can help meet net-zero goals by 2050 by developing and executing the needed projects, including renewables, low-carbon activities, infrastructure, building insulation, and more.

The construction industry is thus on the brink of remarkable expansion: At constant prices, global construction spending is projected to escalate from US\$13 trillion in 2023 to US\$22 trillion in 2040, which would require a Compound Annual Growth Rate (CAGR) of 3.2%.

The industry lacks sufficient capable workers and economic labour productivity (the economic value added per hour worked) has stagnated for decades globally despite technological advancements and improvements by individual firms. Any shortfall in output will cause significant bottlenecks in country-level economic, social, and environmental ambitions and hamper abilities to address critical needs of a growing population or meet societal goals, such as affordable housing and net-zero carbon emissions targets.

Construction Industry Value Chain - World Bank

The global construction industry is the world's largest consumer of raw materials, and constructed objects account for 25%-40% of total carbon emissions in the world. The industry was projected to grow at 4.2% annually between 2018 and 2023 in terms of market value, with expansion opportunities in residential, non-residential, and infrastructure projects. In parallel, the Paris Agreement and its well-below-20C target for global temperature increase has signalled an imperative toward decarbonisation in the public and private sectors, including creating the impetus for a sustainable construction industry.

With increasing populations, urbanisation, and the fact that almost 75% of the infrastructure that will exist in 2050 has yet to be built, the construction industry can only be expected to expand, thus providing a significant opportunity to improve its efficiency and transition toward a low-carbon future.

Chenab Rail Bridge - India's Record-Breaking Engineering Marvel

Spanning the Chenab River in Jammu and Kashmir, the Chenab Rail Bridge is celebrated as one of the world's greatest construction feats. Built as part of the Udhampur-Srinagar-Baramulla Rail project, it provided a vital all-weather rail link between the Kashmir Valley and the rest of India, overcoming some of the planet's most challenging terrain.



Arching about 359m above the riverbed, the bridge is the highest railway bridge in the world, standing taller than the Eiffel Tower. The roughly 1.3km bridge features a sweeping 467m steel arch that supports the railway deck. Engineers erected the arch using cable cranes stretched across the gorge - an extraordinary method for work of such scale.

Remote Himalayan conditions required materials to be moved by helicopters and ropeways where roads were impossible. The design can withstand varying temperatures from -20°C to scorching summers, wind speeds up to 260km/h, and significant seismic activity. More than 25,000 tonnes of high-strength steel ensure a service life of at least 120 years, while blast-resistant elements add strategic security. A fusion of daring design, advanced engineering, and human determination, the Chenab Rail Bridge rightfully claims its place among the greatest construction achievements of our time.

Channel Tunnel - Engineering Gateway Beneath the Sea

The Channel Tunnel, often called the Chunnel, stands as one of the most ambitious engineering projects of the 20th century. Stretching 50.5km (31.4 miles) beneath the English Channel, it creates a direct rail link between Folkestone in the United Kingdom and Coquelles near Calais in France, transforming travel and trade between the two nations.

Conceived after decades of proposals, construction began in 1988 and concluded in 1994. There are three parallel tunnels: Two for high-speed trains and a smaller central service tunnel for maintenance and emergency access. At its deepest point, it lies 75m below the seabed, tucked safely beneath a thick layer of chalk marl which provides natural stability.

The engineering achievements are remarkable. Boring teams worked simultaneously from both the British and French sides, using massive

tunnel-boring machines (TBMs) that advanced through challenging geology while maintaining precise alignment to meet within a margin of mere centimetres. Extensive waterproofing and ventilation systems were designed to handle immense water pressure and ensure safety for both passenger and freight operations. Fire-resistant linings, sophisticated drainage, and advanced air circulation enabled continuous operation under the sea.

The Channel Tunnel dramatically reduces travel time between London and Paris or Brussels, with Eurostar trains completing the London-Paris journey in just 2.5 hours. It also supports significant freight movement, strengthening economic ties across the English Channel.

More than just a transportation corridor, the Channel Tunnel is also a symbol of international collaboration and engineering mastery. The combination of length, depth, and operational complexity places it among the world's greatest underground constructions, demonstrating how innovation and cooperation can overcome formidable natural barriers.

China's South-to-North Water Diversion Project

The Central Route strategically elevates the crest of Danjiangkou Dam from 162m to 176.6m above sea level. This raises the normal water level from 157m to 170m, creating a natural downhill gradient towards Beijing and the North China Plain with minimal pumping. This gravity-driven design drastically reduces energy usage compared to purely pump-based systems.

The reservoir expansions, especially at Danjiangkou, required the relocation of over 300,000 people; it was one of the world's greatest human resettlement projects.

Hong Kong-Zhuhai-Macao Bridge

A 6.7km (4.2 mile) tunnel was built as part of the bridge section under a busy shipping channel to allow unrestricted passage of large vessels.

This tunnel, the world's longest sea Immersed Tube Tunnel, had to be constructed in deep, soft seabed conditions with extremely poor visibility.

Instead of boring through the seabed, engineers constructed 33 massive precast concrete sections (each weighing about 80,000 tonnes or the equivalent of an aircraft carrier) in a factory on an island. These hollow sections were then sealed with temporary bulkheads, floated out to sea, carefully sunk into a pre-dredged trench on the seabed, and connected.

The requirement for the vertical alignment between two connecting sections was a mere $\pm 2\text{mm}$. Achieving this in open sea with currents, waves, and poor visibility was unprecedented. So, engineers developed a revolutionary Continuous Compaction and Forming method for the trench base to create a perfectly level, strong foundation. They then used a sophisticated Waterproof Membrane and Gravel Bed system. Before a tunnel section was lowered, a layer of gravel was laid with a specially designed ship, to an accuracy of $\pm 4\text{cm}$. The section was then positioned using a combination of GPS, sonar, and a Gina gasket (a giant soft rubber seal on the end of each tunnel segment). As the new segment was pulled against the already-placed one, the Gina compressed, creating an initial watertight seal. The incredible precision ensured that when the water between the segments was pumped out, the immense ocean pressure pushed the segments together with perfect alignment, making the final connection permanent and leak-proof.

Evolution of Construction Industry

The Industrial Revolution (18th-19th centuries) transformed construction from craft to industry. Mass production of steel and the invention of the safety elevator enabled skyscrapers to be built in cities such as Chicago and New York. The Home Insurance Building (1885) is widely regarded as the first skyscraper, featuring a steel frame that

allowed greater height with less material. Railways and steamships expanded access to building materials, while mechanised equipment such as steam-powered cranes and pile drivers reduced manual labour. By the early 20th century, reinforced concrete, prefabrication, and mechanised earthmoving became standard. Today's construction integrates digital design, robotics, and advanced materials.

How Risk is Managed in Construction

Construction is inherently risky, involving huge budgets, complex logistics, and hazardous work environments. Risk management starts with hazard identification during the planning phase: Considering soil conditions, weather patterns, and logistical constraints.

Safety management requires enforcing occupational health protocols, providing PPE, and ensuring workers are trained for site-specific hazards.

Financial risk is addressed through fixed-price or guaranteed maximum price contracts, insurance, and contingency funds.

Technical risk is mitigated through thorough geotechnical surveys, peer-reviewed engineering designs, and rigorous quality control.

Environmental risk requires compliance with environmental impact assessments, erosion control, and waste reduction strategies.

Schedule risk is managed with tools such as the Critical Path Method (CPM) and lean construction planning, ensuring that key milestones are met.

Legal risk is reduced by ensuring contracts, designs, and operations comply with all relevant codes and laws.

Successful projects treat risk management as a continuous process, reviewed and updated at every stage from design through post-completion maintenance.

Fastest Building Constructions in the World - Broad Sustainable Building (BSB)

In the modern construction industry, speed and efficiency have become critical performance indicators. While quality and safety remain non-negotiable, advancements in modular construction, prefabrication technology, and digital project management enable engineers to achieve record-breaking timelines that were once considered impossible. From skyscrapers to residential buildings, several projects worldwide pushed the limits of construction speed without compromising on durability, sustainability, or aesthetics.

- The Mini Sky City project in China stunned the global engineering community when a 57-storey skyscraper was erected in just 19 days. Using a Lego-like modular approach, BSB fabricated 93% of the building components in a factory and transporting them to the site. Each day, workers installed three floors, a pace unheard of in high-rise construction. The modules came with pre-installed utilities, such as electrical conduits, plumbing, and HVAC ducts, drastically reducing on-site labour.
- The T30 Hotel Tower and Ark Hotel in China represent earlier milestones in BSB's quest for ultra-fast, sustainable construction. Using advanced prefabrication techniques, the company assembled 30-storey hotels in just over two weeks.
- In 2021, BSB shattered its previous records by completing a fully functional 10-storey apartment block in less than 29 hours. The project leveraged prefabricated container-sized units stacked together with bolt-fastening systems rather than traditional concrete curing methods.
- The Shelby County Home, USA, was built in 3 hours, 26 minutes. This small-scale project set the world record for the fastest single-family home construction.



Using pre-cut timber framing kits and highly synchronised workflows, volunteers completed the structure in under four hours.

- Crystal Palace, UK, was built in 190 days (1851). Though built in the 19th century, the Crystal Palace remains one of history's most impressive fast-track projects. Constructed for the Great Exhibition of 1851, its prefabricated cast-iron frame and standardised glass panels allowed an unprecedented pace of assembly.

Ancient Overhead Aqueducts

Ancient overhead aqueducts stand as one of the most remarkable achievements in the history of engineering and architecture. Designed to transport water from distant sources to cities, farmlands, and industrial centres, these monumental structures not only addressed the basic needs of growing civilisations but also demonstrated incredible ingenuity, precision, and craftsmanship.

Civilisations such as the Romans, Greeks, Persians, Chinese, and Indians mastered the science of hydraulics and construction techniques to create aqueducts that had endured for centuries.

Notable examples of ancient overhead aqueducts are Pont du Gard, France (Roman, 1st Century CE), Aqueduct of Segovia and Spain (Roman, 1st-2nd Century CE).

First, ancient engineers had to identify a reliable water source such as a river, spring, or reservoir, at a higher elevation than the destination. The key objective was to maintain a gentle, continuous gradient so that water could flow purely by gravity. Too steep a slope would cause erosion, while a too shallow slope would cause stagnation.

Overhead aqueducts consisted of multiple components designed for durability, stability, and functionality. The topmost channel which carried the water was built with stone, brick, or concrete, lined with waterproof mortar to prevent leakage. Romans used *opus signinum*, a mixture of lime, crushed tiles, and volcanic ash.

Where the terrain dipped, aqueducts were raised on arched bridges. Piers were constructed from stone or brick and founded on solid rock for stability. Arches distributed weight evenly, with a keystone locking each arch. Multiple tiers of arches were used for tall structures, such as the Pont du Gard in France. ⚠️

Local Ingenious Construction: Palmyra Palm Frond Roofing at Sri Pak Pra Resort in Phatthalung, South Thailand

by
Ng Li Li



Well-preserved heritage site at Dubrovnik, Croatia, which is now a popular tourist destination during Repair Option Selection stage

Dotted in the tranquil wetlands and lush landscapes of Phatthalung in south Thailand, many eco-friendly tourist resorts use palmyra palm frond roofing in their architectural designs. This construction approach goes beyond aesthetics; it symbolises sustainability, cultural heritage, and harmony with nature.

By using locally sourced materials and traditional techniques, the resorts create a warm, rustic ambience that celebrates the

ingenuity of the local communities while offering visitors an immersive experience of local craftsmanship.

Source of Palmyra Palm Fronds

The palmyra palm (*Borassus flabellifer*), known locally as ton tan, thrives in south Thailand's coastal plains, farmlands, and village edges. Phatthalung, with its fertile soil and tropical climate, has an abundant number of these hardy palms.



Palmyra palms grow abundantly around Thala Noi Lake.

- **Ecological abundance:** Palmyra palms grow naturally around paddy fields as well as along riverbanks and rural roadsides, making them an easily renewable resource.
- **Sustainable harvesting:** Skilled local harvesters select and cut mature, healthy fan-shaped leaves without harming the tree. These are then sun-dried and sorted for size and quality.
- **Community-based sourcing:** Many resorts partner directly with local villagers and craftsmen to source the palm fronds, supporting community livelihoods while maintaining authenticity.

- Softer and easier to weave into panels, but less durable under direct sunlight.
- Often used as roofing for temporary shelters, outdoor kiosks, or small gazebos.

3. Coconut Palm Fronds (Supplementary Use)

- Readily available in coastal areas but used mainly for short-term construction or for decorative accents due to shorter lifespan.

High-end tourist resorts prefer palmyra fronds because they have a polished, natural appearance and can withstand Phatthalung's humid climate better than other palm species.

Types of Palm Leaves Used in Roofing

While several palm species grow in Phatthalung, the palmyra palm is the one most commonly picked for roofing because of its durability, thickness, and aesthetic appeal. Leaves of other palms are occasionally used, mostly for temporary structures or as decorative features.

1. Palmyra Palm Fronds (primary material)

- **Shape:** Large, fan-shaped, and fibrous.
- **Durability:** Superior to other palms due to thicker, more UV-resistant fibres.
- **Processing:** Fronds are trimmed, sun-cured, and sometimes smoke-treated to improve longevity and pest resistance.

2. Nipa Palm Fronds (Occasionally Used)

- Commonly found in the brackish wetlands near Thale Noi.

Construction Techniques

Palmyra palm roofs are constructed with an emphasis on traditional craftsmanship combined with modern engineering to ensure durability and comfort.

- 1. Preparation:** Mature leaves are dried, flattened, and sometimes smoke-treated for improved strength and to repel insects. Some resorts apply borate or natural lime solutions for added termite and fungal resistance.
- 2. Roof Framework:** Built from bamboo or treated timber to match the natural aesthetic. Roofs are designed with a steep pitch ($\geq 45^\circ$) to allow quick rainwater runoff, crucial in the region's monsoon climate.
- 3. Layering Technique:** Palmyra fronds are woven into panels or bundled into overlapping layers to ensure waterproofing.



The aesthetic motif of Palmyra fronds, seen from underneath the timber truss roof, presents an uncommon feature that evokes a pleasantly cool atmosphere.

and insulation. Extra layering is applied at the eaves and ridges to protect against wind-driven rain.

4. Integration with Modern Features:

Fire-retardant barriers or treated underlayments are discreetly added for safety. Ventilation gaps are designed into the structure to maintain airflow and to keep interiors naturally cool.

The aesthetic motif of Palmyra fronds, seen from underneath the timber truss roof, presents an uncommon feature that evokes a pleasantly cool atmosphere.

Lifespan & Maintenance

Palmyra palm frond roofing, when properly constructed and maintained, can last 7-12 years, significantly longer than nipa or coconut fronds. Factors affecting lifespan include:

- Roof pitch: Steeper angles improve durability by preventing water retention.
- Climate exposure: Roofs exposed to heavy monsoon rains or direct sunlight may need earlier rethatching in vulnerable sections.

- Routine inspections: Annual maintenance to replace worn panels or repair ridge areas will extend overall service life.

By combining traditional knowledge with modern protective treatments, many Phatthalung resorts are able to maintain pristine-looking palm frond roofs for more than a decade.

Advantages of Palmyra Roofing

- Aesthetic appeal: Creates a tropical, rustic ambience that attracts eco-conscious travellers.
- Thermal comfort: The layered leaves provide natural insulation, keeping interiors cooler compared to metal or concrete roofs.
- Eco-friendly and sustainable: Locally sourced, biodegradable, and renewable.
- Supports local communities: Resorts often engage villagers and craftsmen, strengthening rural economies and preserving traditional skills.
- Acoustic benefits: Palm thatch muffles rain impact, creating a serene, natural environment.



The bamboo roof truss, skillfully crafted and finished with Palmyra palm fronds, combines creative artistry with sustainable design.

Drawbacks & Challenges

- Fire risk: Dried leaves are naturally combustible if untreated.
- Regular maintenance: Roofs require periodic inspections and repairs.
- Pests and decay: Without proper curing and treatment, palm fronds are vulnerable to attack by termites, fungi, and rodents.
- Wind resistance: Needs secure fastening and multiple overlaps to withstand tropical storms.

These challenges are typically addressed using modern treatments, improved construction techniques, and careful maintenance schedules.

Fire Prevention Measures

Tourist resorts in Phatthalung prioritise safety without compromising on the natural aesthetic:

- Material Treatments. Palmyra fronds are often soaked in borate solutions or coated with eco-friendly fire-retardant sprays.
- Design Considerations. Kitchens are separated from main guest pavilions to reduce risk. Non-combustible ridge caps and clay-lined barriers are incorporated discreetly.
- Site Planning. Resorts maintain open buffer zones around structures which are free from dry vegetation and fuel sources.
- Emergency Readiness. Fire extinguishers, smoke detectors, and water barrels are strategically placed throughout the property.

Where Palmyra Palm Roofing is Widely Used

- Tourist resorts and eco-lodges around Thale Noi Lake, Songkhla Lake Basin, and rural Phatthalung.
- Fishermen's huts and lakeside shelters, where quick, breathable roofing is ideal for hot, humid environments.
- Community pavilions, homestays, and nature retreats that emphasise cultural immersion and sustainability.

Conclusion

Palmyra palm frond roofing represents a fusion of tradition and modernity. By adopting locally sourced materials and time-honoured techniques, the resorts in Phatthalung not only create a serene, eco-friendly atmosphere but also honour the craftsmanship of local communities.

For travellers, the experience is more than visual; it's sensory. Guests hear the soft patter of rain on palm fronds, feel the natural coolness beneath the shade, and witness firsthand how local ingenuity transforms simple materials into sustainable architectural beauty.

In an era where sustainability and cultural preservation are paramount, these resorts demonstrate that modern tourism and traditional wisdom can coexist beautifully. 🌿



Sungai Segget Beautification Project

by
Lee Soo Leng

After having spent some years away from Johor Bahru, it was a pleasant surprise when I strolled along Jalan Wong Ah Fook and observed the totally transformed Sungai Segget, a 3.7km river that cuts through downtown Johor Bahru.

On the upper reach along Jalan Wong Ah Fook, there was no sight of the once smelly river but a wide walkway with a shallow water channel filled with colourful fish. A major part of walkway is beautifully tiled with three zones of attractions.

1. **Heritage/History Zone:** Features elements such as Plaza Seaview and traditional Bugis boat sculptures, celebrating the historical significance of the river.
2. **Arts/Culture Zone:** Showcases local art installations, including steel sculptures symbolising the state identity, and an interactive tunnel with light displays.
3. **Leisure/Recreation Zone:** Provides spaces for relaxation and community activities, enhancing the liveability of the area.



Photo 1: Part of walkway at the upper reach of Jalan Wong Ah Fook is a shallow channel on a concrete slab.

The Sungai Segget Rejuvenation Project is a transformative initiative to revitalise the city's core by addressing environmental degradation, engineering challenges, and urban aesthetics.

Sungai Segget once played a pivotal role in the city's historical and economic development. The river was integral to Johor Bahru's development, serving as a bustling trade route. However, rapid urbanisation led to severe pollution, turning it into one of the country's most contaminated waterways.

The project, initiated by the Iskandar Regional Development Authority (IRDA) in 2013, sought to improve water quality, reduce pollution, mitigate urban flooding, enhance the city's image and liveability as well as preserve and celebrate cultural heritage.

One of the major challenges was to identify and resolve the sources of pollution in the upper catchment, especially waste discharged into Sg. Segget. To overcome this, a Centralised Sewage Treatment Plant (CSTP) was constructed to treat wastewater before it was released back into the river. Underground pipes were installed to collect sewage from adjacent buildings, preventing direct discharge into the river.



Photo 2: Shallow channel with colourful fish and a pedestrian rest area offer a tranquil environment along the usually busy Jalan Wong Ah Fook.



Photo 3: Part of the shallow channel flows beneath the pedestrian walkway.

The river beautification project paid off when, upon completion, the water quality improved significantly and there were new signs of aquatic life. The project's success in environmental restoration was recognised with the WeGO Award in the Sustainable City category in 2020.

In summary, the Sungai Segget Rejuvenation Project exemplifies a holistic approach to urban renewal, successfully addressing environmental concerns, engineering challenges, and cultural preservation as well as transforming the Johor Bahru cityscape. 🏡



Photo 4: The dividing line between the upper and lower reaches of Sg. Segget. The upper reach was constructed with a concrete slab over it while the lower reach was left open.

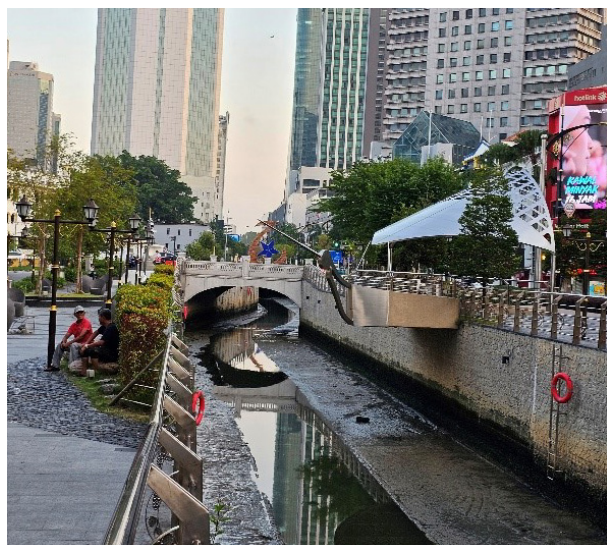
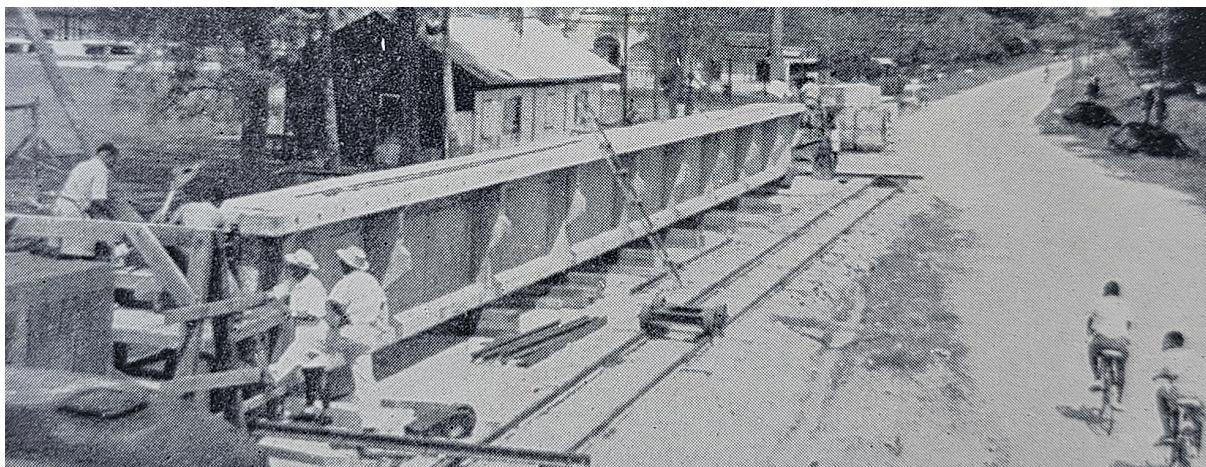


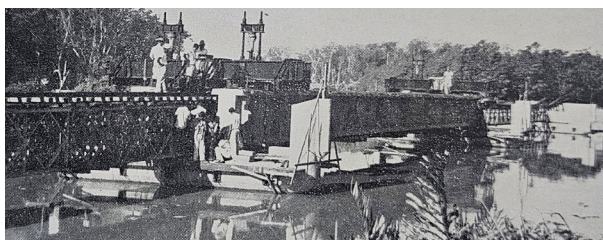
Photo 5: Another view from the lower reach showing landscaped areas which serve as resting places for pedestrians.

Construction of Telok Datoh Bridge

by
Cheo Hong Keyong



The casting of prestressed concrete beams was carried out using steel formwork fabricated at the PWD Federal Workshop in 1959.



Launching of prestressed concrete beams using PWD labour force

The Telok Datoh Bridge in Selangor was built under the management of the Public Works Department PWD (JKR) with several parties involved. Piling works, which employed 24-inch and 34-inch diameter reinforced-concrete piles, were awarded in 1959 to the Malayan agent for Raymond Prestressed Concrete Piles. The 100ft piles were delivered in a barge hired from Malayan Railways and transported by sea from Port Swettenham to Telok Datoh.

By the end of 1959, a separate contract for the reinforced-concrete piers was awarded to another contractor. In 1960, the 100ft

prestressed concrete beams were casted by JKR staff using the Lee-McCall post-tensioning system, with steel formwork fabricated at the PWD Federal workshop. The launching of the 100ft, 56-ton prestressed beams was completed by the JKR workforce under the supervision of PWD engineers. 🏗️

Reference

1. Annual Report of the PWD 1959 & 1960

KYODO PIPE STANDARD GALVANISED STEEL CONDUIT



BS 31 CLASS B (SCREWED) / MANUFACTURER'S STANDARD

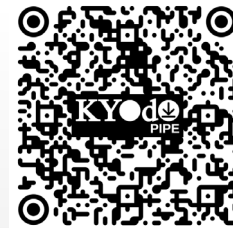
NOMINAL SIZE	OUTSIDE DIAMETER				WALL THICKNESS				CALCULATED WEIGHT WITH COUPLER			NUMBERS OF THREADS	LENGTH OF THREADS			
	MINIMUM		MAXIMUM		MINIMUM		MAXIMUM						MINIMUM		MAXIMUM	
in	mm	in	mm	in	mm	in	mm	in	kg/m	kg/ft	lb/ft	PER INCH	mm	in	mm	in
¾	18.76	0.7387	19.05	0.7500	1.52	0.060	1.63	0.064	0.713	0.217	0.479	16	12.70	0.5000	14.29	0.5625
1	25.11	0.9887	25.40	1.0000	1.52	0.060	1.63	0.064	0.972	0.296	0.653	16	15.88	0.6259	17.46	0.6875
1¼	31.46	1.2387	31.75	1.2500	1.52	0.060	1.63	0.064	1.240	0.376	0.830	16	17.46	0.6875	19.05	0.7500
1½	37.80	1.4880	38.10	1.5000	1.73	0.068	1.83	0.072	1.680	0.511	1.130	14	19.05	0.7500	20.64	0.8125
2	50.50	1.9880	50.80	2.0000	1.93	0.076	2.03	0.080	2.510	0.765	1.690	14	22.23	0.8750	23.81	0.9375

MS 275 / BS 4568 CLASS 3 (SCREWED) / MANUFACTURER'S STANDARD

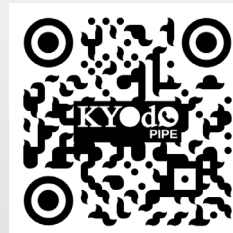
NOMINAL SIZE	OUTSIDE DIAMETER		WALL THICKNESS	CALCULATED WEIGHT WITH COUPLER		PITCH	LENGTH OF THREADS	
	MINIMUM	MAXIMUM		MINIMUM	MAXIMUM		MINIMUM	MAXIMUM
mm	mm	mm	mm	kg/m	kg/m	mm	mm	mm
20	19.7	20.0	1.6 ± 0.15	0.643	0.783	1.5	13	15
25	24.6	25.0	1.6 ± 0.15	0.811	0.995	1.5	16	18
32	31.6	32.0	1.6 ± 0.15	1.069	1.301	1.5	18	20

MS IEC 61386-1 / MS 61386-21 CONDUIT SYSTEM FOR CABLE MANAGEMENT

NOMINAL SIZE	OUTSIDE DIAMETER		INSIDE DIAMETER	EXTERNAL THREAD LENGTHS
	MINIMUM	MAXIMUM	MINIMUM	MINIMUM
mm	mm	mm	mm	mm
20	19.7	20.0	1.6 ± 0.15	13
25	24.6	25.0	1.6 ± 0.15	16
32	31.6	32.0	1.6 ± 0.15	18



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