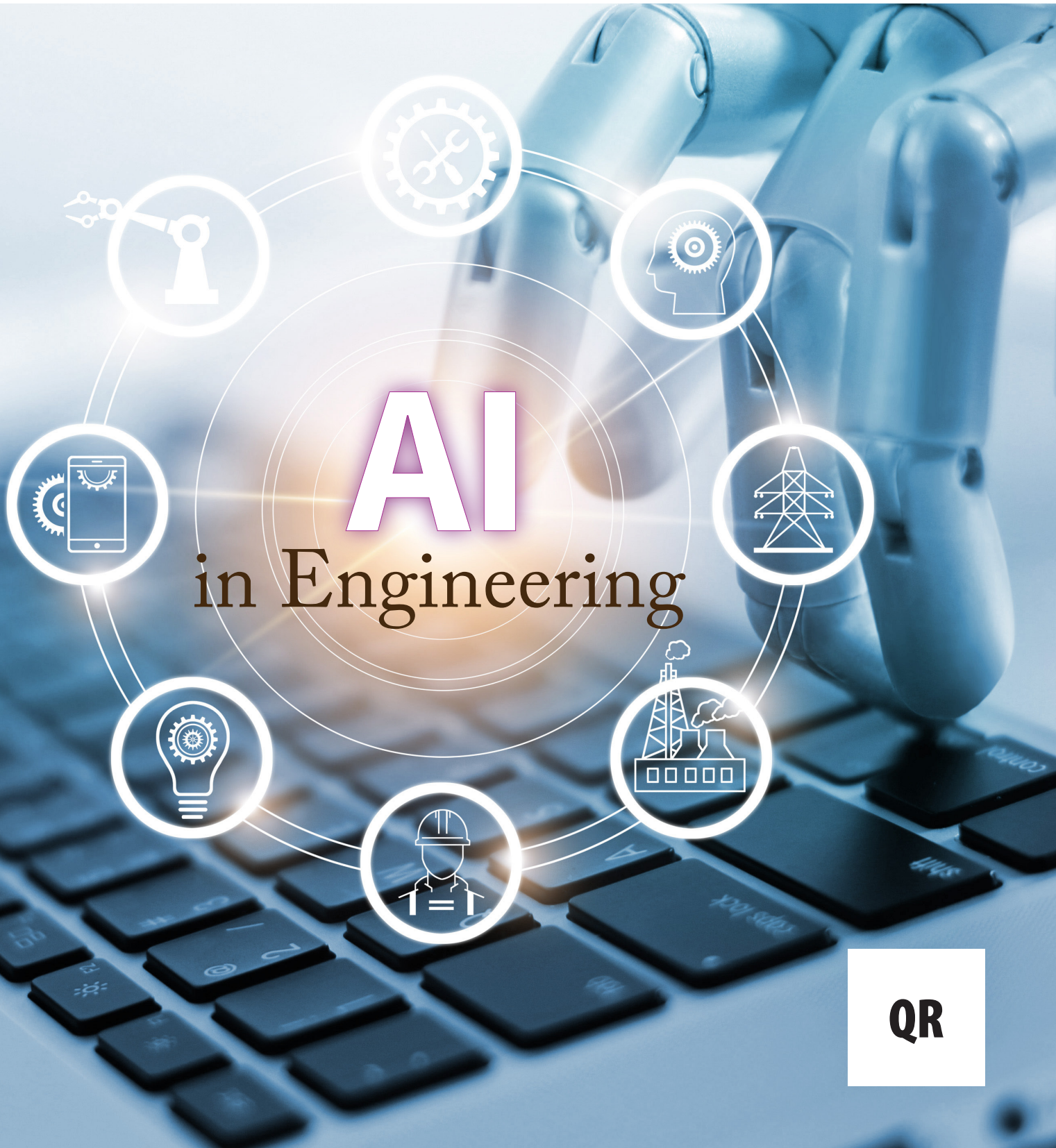


THE
VOL.102
APRIL-JUNE 2025

INGENIEUR

MAGAZINE OF THE BOARD OF ENGINEERS MALAYSIA



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EMPOWERING ENGINEERS, BUILDING THE FUTURE

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.

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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.

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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.

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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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PUBLISHER

Lembaga Jurutera Malaysia

Tingkat 17 Blok F, Ibu Pejabat JKR,

Jalan Sultan Salahuddin,

50580 Kuala Lumpur.

Tel: 03-2698 0590, 03-2691 2090 Fax: 03-2692 5017

E-mail: publication@bem.org.my

Website: www.bem.org.my

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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BEM NATIONAL ENGINEERING CONVENTION

Engineering Malaysia, Integrating ASEAN

 Connexion Conference & Event Centre (NEXUS),
Level 3A, Nexus, Bangsar South City,
Kuala Lumpur

 19TH – 22ND August 2025

 Officiated by: **YB Dato'Sri Alexandar Nanta Linggi**

OBJECTIVE

- To strengthen regional engineering collaboration and strategic partnership
- To provide a national platform for professional development and regulatory updates
- To celebrate engineering excellence and promote recognition of the profession
- To inspire and nurture future engineering leaders



CONFERENCE
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CEREMONY

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- Keynote Address: Engineering Malaysia, Integrating ASEAN
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- Global Reach, Local Expertise: How Malaysian Engineers Can Expand Internationally
- Forum on Professional Mobility of ASEAN, ASEAN Plus & International Engineering Alliance
- Cyber Security Threats: Unifying ASEAN through Cyber Cooperation
- Predictive Rotating Equipment Analytics (PROTEAN)
- From Commitment to Recognition: Our Journey to SHE Excellence
- Engineering Leadership Forum 2025: From Vision to Impact
- Forum Pelarasan Gaji Permulaan Profesion Kejuruteraan
- Updates on Amendment to REA 1967
- Briefing on Professional Competency Examination
- Towards Global Recognition: Benchmarking CPD for the Malaysian Engineering Profession
- Future of Programme Accreditation in Malaysia: Exploring AI-Infused-Principle-Based Assessment for Engineering Programmes
- OBE Acculturation in Malaysia towards Global Competence
- Engineering the Shift: From Academic Pathways to TVET Excellence

DAY 1 : 19TH AUGUST 2025

- **FORUM ON BUSINESS OPPORTUNITIES & CHALLENGES**
Auditorium, Level 3A, Nexus
- **WORKSHOP ON CONSTRUCTION DESIGN MANAGEMENT (CDM) PROFESSIONAL TRAINED PERSON**
Continuum, Level 3A, Nexus
- **WORKSHOP ON OUTCOME-BASED PAE (EXAMINERS)**
Reflexion, Level 3A, Nexus
- **REGULATORY BODIES COLLABORATION MEETING**
Prism, Level 3A, Nexus

DAY 2 : 20TH AUGUST 2025

- **BEM NEC SEMINAR**
(Nexus 1 & 2, Level 3A, Nexus)
- **WORKSHOP ON CONSTRUCTION DESIGN MANAGEMENT (CDM) REGULATION FOR DESIGNER**
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- **FUTURE ENGINEERING TALENTS GATEWAY**
Spectrum & Prism, Level 3A, Nexus

DAY 3 : 21ST AUGUST 2025

- **BEM NEC SEMINAR**
Nexus 1 & 2, Level 3A, Nexus
- **WORKSHOP ON OUTCOME-BASED PAE (CANDIDATES)**
Spectrum, Prism & Continuum, Level 3A, Nexus
- **PROFESSIONAL CONFERMENT CEREMONY**
Auditorium, Level 3A, Nexus

DAY 4 : 22ND AUGUST 2025

- **WORKSHOP ON ENVIRONMENTAL, SOCIAL, AND GOVERNANCE (ESG)**
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Puan Nik Kamaliah
+6019.2828.016
nikkamaliah@bem.org.my

Puan Nuril Fathihah
+6013.3451.816
nuril.fathihah@bem.org.my

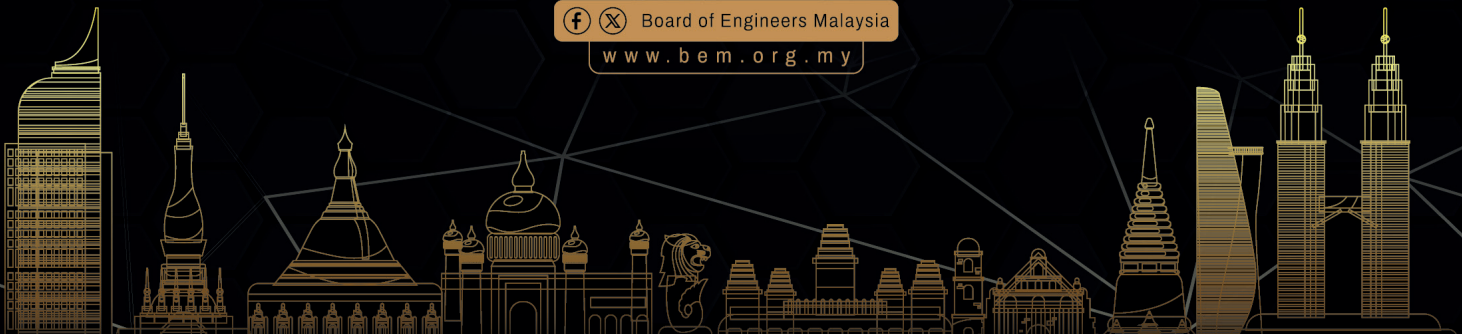
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Artificial Intelligence in Engineering



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

We are now on the threshold of a new era when artificial intelligence (AI) is rapidly reshaping the landscape of engineering across all disciplines. From predictive maintenance and smart design automation to digital twins and autonomous systems, AI is no longer a distant concept but a present reality, driving innovation and efficiency at an unprecedented scale.

The pace of change is accelerating. Emerging trends such as generative design, AI-driven project management, and real-time analytics are transforming traditional workflows. To remain relevant and competitive, it is essential that engineers embrace updated technologies, develop strong digital competencies, and integrate AI literacy into both education and professional development.

The few government agencies such as Malaysian Research Accelerator for Technology

and Innovation (MRANTI) and National AI Office (NAIO) play a crucial role in guiding the respective profession through this transformation. By fostering a culture that values IT-savviness, cross-disciplinary collaboration, and ethical application of AI, they can empower our engineers to lead, not follow, in the age of intelligent systems.

Taking cognisance of the efficiency and convenience of AI, the article on Global e-Governance expresses its importance because it ensures that governments around the world can effectively, transparently, and securely manage digital technologies in a way that benefits society, especially in an increasingly interconnected world.

Let us ensure the engineering profession not only adapts but thrives - shaping a future where human ingenuity and AI work hand in hand to build smarter, safer, and more sustainable solutions. 🤖



CALL FOR ARTICLES

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

Vol. 103 July-Sept 2025
Maritime Engineering

Vol. 104 Oct-Dec 2025
Construction Industry

Vol. 105 Jan-Mar 2026
Engineering Practice

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 42 for the latest rate card and booking form.

The Ingenieur e-Magazine on **SMARTPHONES & IPADS**

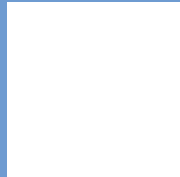
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AI and Engineering Excellence

by
Dato' Prof. Ir. Dr. Eric
KH Goh, FASc,
Prof. Dr. Zulkifli
Mohamad Ariff,
Dato' Ir. Fong Tian Yong

Board of Engineers Malaysia



Source: Modified from EngineeringCom

Worldwide, industrial sectors are actively incorporating groundbreaking Artificial Intelligence (AI) technologies and practices for continuous business success. Malaysia has the potential to be a regional AI tech innovator due to our pro-active initiative in spearheading digital transformation growth, strong infrastructure, a strategic location, the existence of technology-savvy engineers and a rapidly growing digital

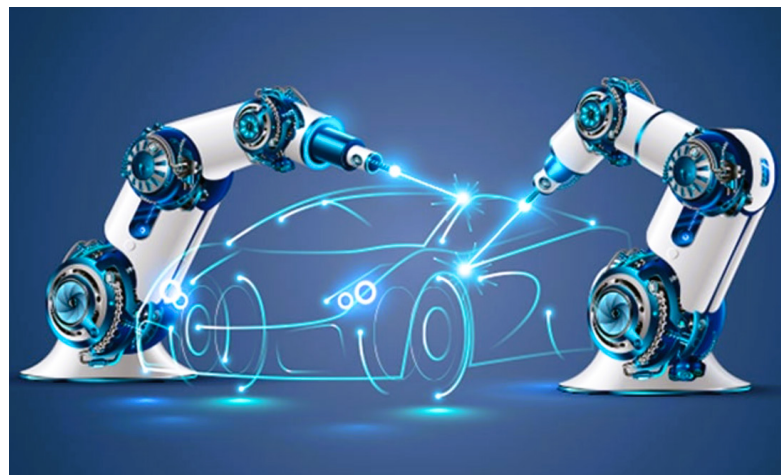
economy. The nation's strategic AI Technology Action Plan 2026-2030 consists of the following key elements: AI Adoption Regulatory Framework, Acceleration of AI Technology Adaptation, AI Code of Ethics, AI Impact Studies, National AI Trend Reporting and Datasets Information related to AI Technology. The subsequent set-up of the National Artificial Intelligence Office (NAIO), tasked with the responsibility for AI governance and development, on 12 December 2024,

established Malaysia as a leader in AI innovation and competitiveness on the global stage. We went the extra mile with the exclusive design of the Malaysia Digital Catalytic Programmes to accelerate growth in high-potential digital sectors through public-private collaborations. Special tax incentives, offered to encourage foreign and local investments in digital services and solutions, were successful in drawing in major global players to set up operations in the country. Nationwide, the engineering fraternity and respective industrial sectors are experiencing an increase in demand for AI application know-how in project design, implementation and problem solving. The holistic benefits of AI applications such as faster, more precise and more efficient production decision-making, are all aimed at enhancing workflow efficiency. Malaysia's Gateway, Amplify, Invest & Nurture (GAIN) Initiative, complemented with various grants such as the Digital Content Grant (DCG), Malaysia Digital X-Port Grant (MDXG) and the Malaysia Digital Catalyst Grant (MDCG), are additional benefits to empower high-potential Malaysian companies with the tools, skills and networks necessary for global expansion. With the primary aim to focus on building talent and skills to further enhance the competitiveness of the nation's human capital, a notable effort is the recent allocation of RM50 million in the National Budget for AI education. Thanks to the recent leap in top-trending digital technologies, AI has emerged as an invaluable key tool for the respective industrial sectors to economically progress towards world class engineering excellence, via improvement in remote data collection, enhancement in project management and productivity. All this results in a positive upsurge in company profits. It's definitely a win-win situation for all.

AI Concepts

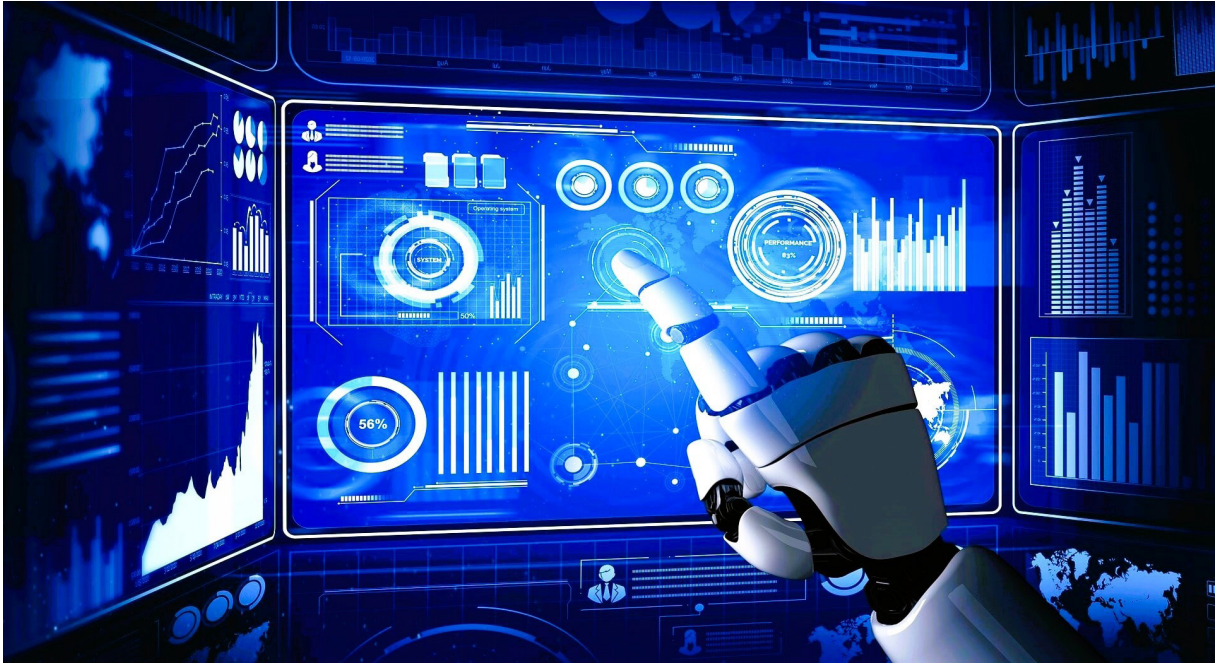
AI refers to the simulation of human intelligence using computer systems. It is the ability of a digital system to carry out daily tasks commonly performed by industrial site personnel. AI technology is frequently applied in the design

of specialised digital systems endowed with algorithms to analyse large sensor data sets on human and cognitive skills of the project workforce, to discover, reason, and learn from past events with the primary aim to precisely and repeatedly perform any designated task continuously and efficiently. AI is also able to eventually adapt to new inputs without the need to be programmed explicitly for every new task. Concisely, AI also refers to machines and software tools with the ability for on-site management skills learning, human decision-making and the option to solve problems. Using machine learning algorithms with intelligence, AI can enhance overall engineering operations via holistic site management, achievement of daily production quota, optimisation of product supply chains and adhere to occupational safety and environmental standards at industrial sites.



Source: Modified from Binmile

Some key components of AI technology include Expert Systems, Machine Learning, Generative AI and Natural Language Processing. The many outstanding benefits of applied smart AI systems include faster corporate decision making, higher construction site/manufacturing plant production, improved product quality through smart automation, enhanced customer/client public relations through personalised problem-solving messages, rapid information processing, data analysis and product trend risk forecasting for effective business stability.



Source: modified from Instrumental Tools

Key AI Applications Towards Global Engineering Excellence

The aim for global engineering excellence in the application of AI smart technologies is increased productivity complemented with optimum economic benefits and successful project outputs while operating on the original final budget as planned. Cost-effective state-of-the-art AI technologies and work practices should focus on the best, most efficient, accurate and effective techniques to eventually increase overall profits and good governance practices.

Innovations in AI technology should thus assist in the overall accomplishment of any demanding task, financial savings in engineering planning, confidence in infrastructure design, accurate data analysis and finally client-compliant project outcomes. The specifications of AI technology are improving rapidly, complemented by the reduction in procurement costs.

We are confident that strategic applications of AI can increase productivity and even shorten the time for accurate project decision-making

from the present timeframe of weeks to possibly just hours. Listed below are highlights of key AI technologies applicable to industries striving for engineering excellence, optimum production, improved efficiency and progressive business outcomes.

- **Digital Twins**

Digital Twins technology can realistically create virtual simulation replicas of construction sites or industrial plant production processes, allowing for accurate simulation and analysis of different scenarios to optimise site operations and to reduce management risks with regards to production, equipment downtime or even occupational safeguards and environment perils. Integration of real-time data compiled for the Digital Twins set-up enhances predictive analytics and optimises production processes for cost savings and thus eventual business success.

- **Robotic Process Automation**

Robotic Process Automation (RPA), a software-based business process automation technology, is used to emulate any site/production personnel in the execution of repetitive engineering processes. RPA systems

can intelligently develop a list of actions to automate a task by first using the Graphical User Interface (GUI) to observe and study in detail the actions carried out by the respective personnel to perform a designated task. Subsequently, the RPA system can then programme the GUI to confidently carry out the task repeatedly. These job scopes include the execution of low-value, repetitive or boring tasks such as data input, processing daily business transactions, copying source data, interpreting applications or replying to the usual sales emails. RPA technology saves time, improves productivity and minimises potential human errors/accidents due to worker fatigue. Other key uses of RPA include remote operation management, automatic data entry, creating invoices, support diagnostics and even performing precision tasks.

- **Digital Smart Vision: Augmented Reality & Virtual Reality**

Digital Smart Vision Technology, via interactive Augmented Reality (AR) and Virtual Reality (VR), are notable trends with potential in projects such as professional training, education, e-commerce and marketing. The major criteria differences between AR and VR are:

- The AR visual set-up uses a real-world setting whereas the VR set-up is fully virtual (computer-generated simulation).
- AR technology can superimpose/morph mundane physical real-world worksite background with digitally-generated virtual information overlay while VR is confined to enriching the computer-simulated reality.
- VR technology replaces the real-world environment of the user whereas AR systems project relevant information onto what the user is looking at, such as a construction site/factory floor production layout with all the real-time data inserted.

This ingenious, fascinating and smart real-life immersive professional training simulator concept is most advantageous when specialised equipment manufacturers need to

impart work experience knowledge to trainee machine operators. With the installation of real-time sensory perception and motion feedback mechanisms on the training modules to reflect on-site job challenges such as working on uneven, soft ground sites, slippery roads or steep slope terrains, the trainees can experience an accurate representation of actual work site scenarios. The unique training programmes carried out are dynamic, realistic and task scenario-centric since they are based on the actual work experiences of senior operators and typical worksite conditions. Task efficiency performance, an extra bonus, can also be assessed and analysed instantaneously at every training session to evaluate an individual's competency and skill progress.

- **Autonomous/ Self-Driving/ Remote Fleet Technology**

Autonomous-powered lorries and other vehicles can transport materials and workers using smart AI but with improved safety, operational efficiency and cost savings. AI robotic piling and rock breaking equipment can efficiently enhance task precision, reduce possible human errors and operate efficiently round the clock according to 24/7 work schedules. The aim of effective remote fleet management is to provide real-time detailed asset information and evaluation updates on any industrial site operation. This allows a top management overview to be strategically carried out for immediate decision-making on the operating efficiency of the equipment used at the site. Moreover, this can be done from the management head office or from an office anywhere in the world. Equipment productivity is defined as the monitoring of on-going production, complemented with the management of job site efficiency. This AI productivity solution enables top management personnel to control the manufacturing process in real-time to meet the product specifications of clients with the help of high-precision technology to increase the accuracy and efficiency of production schedules.



Source: modified
from MinioTec

- **Smart Industrial Drones**

Major benefits of using drone engineering include more than 99% results accuracy, 85% faster time to complete tasks and 5 times cheaper cost for overall project implementation. Imagine being able to successfully complete an aerial survey of 2-hectare site in 6 minutes, with high resolution data outputs or even producing an accurate digital site volume model with 3cm site accuracy. Yes, this feat is possible with the use of industrial drones. Drone technology is progressively improving and in tandem with reduced pricing. We are confident that geo-referenced drones can be used effectively to enhance site surveys, site inspections, logistics, engineering site productivity or even shorten the time for accurate environmental assessment from weeks to just a few hours.

- **Internet of Things (IoT)**

Interconnected Digital Network, more popularly known as the Internet, is a vast global digital communications system connecting computer systems and other electronic/digital devices across the globe. Some important



Source: modified from FullCircle

uses of the Internet include ready access to information from millions of websites, the ability to communicate via virtual business meetings and technical seminars, the option to send and receive business messages/ letters via emails, on-line commercial transactions/banking and the option to send images, documents, video/audio files to any industrial-centred business company worldwide. Internet data traffic is growing at an amazing rate of about 60% per year globally.

Key factors affecting Internet speeds are strong global commitment and investment of the respective governments, infrastructure set-up and proximity to submarine fibre-optic cables as these massive cables transmit about 97% of the world's communicated data. IoT Network technology aims to further progress the AI-savvy era with ultra-fast transmission speeds, ultra-low latency, better traffic capacity and improved network efficiency. Major benefits of high-speed IoT technology

include making businesses more efficient, ultra-fast communications/business search, effective connectivity and operation of smart devices, improved customer supply chain experience, real-time rapid data analysis on equipment health, fast access to production information, quality control of marketable manufactured products and finally, the smart option of confident decision making. Other supplementary top-trending AI applications, and their corresponding functions, are:

AI Applications	Functions
AI-Enhanced Building Information Modelling	Dynamic Infrastructure Modelling integrated with AI info databases
AI-Driven Engineering Design Optimisation	Ability to optimise engineering design parameters using Generative Algorithms
Enhancement of Energy/ Power Usage	Power Load Balancing and Energy Savings using Machine-Learning Models
Smart Work Scheduling and Resource Allocation	Development of Efficient Project Timelines using Machine-Language Algorithms
Predictive Maintenance	Ability to assess/ predict equipment failures and scheduled maintenance using Sensor Data Analytics
Computer Vision for Equipment Inspections	Automated equipment defect detection using Image Recognition Technology
Intelligent Waste Sorting/ Management	Automated Waste Separation/Sorting using Digital Vision and Robotics Technology
Smart Occupational Safety Monitoring & Management	Real-time Safety Hazard Alerts using Digital Vision and IoT Technology
Equipment and Process ESG Emission Reduction	Optimisation of Combustion and Filtration Systems in Manufacturing/Site Processes
Supply Chain Optimisation	Smart AI specially used in Demand Supply Forecasting and Inventory Management

Cost Savings Using AI for Strategic Industries

From industrial case studies carried out around the world on the economic benefits of using AI in the respective engineering sectors, the following findings were noted:



Source: modified from FullCircle

Industrial Sectors	Top AI Applications used	% Cost Savings
Construction	- BIM - Smart Scheduling - Inspection Schedule	15 - 25%
Manufacturing	- Robotics - Quality Control - Predictive Maintenance	20 - 30%
Power/Electric Generation	- Load Forecasting - Predictive Maintenance - Emission/Pollution Control	12 - 20%
Oil & Gas	- AI Drilling Management - Oil/Gas Pipeline Management - Emission Reduction	20 - 30%
Mineral Dev. (Mining & Quarrying)	- Prospecting/Site Survey & Design - Autonomous Vehicles/Trucks - Safety & Environmental Monitoring	20 - 35%
Agriculture	- Crop Yield Forecasting - Aerial Field Mapping - Smart AI Irrigation Mangt.	15 - 25%
Aviation	- Flight Optimisation - Predictive Maintenance - Flight Scheduling	8 - 15%
Waste Mangt.	- Waste Sorting/Segregation - Rubbish Trucks Route Optimisation - Waste Collection Scheduling	10 - 20%

Conclusion

The prime objective of this special feature to bridge advanced AI technology and practical engineering solutions has been achieved. The engineering profession has always been acknowledged worldwide as the inspiration in the design, fabrication, construction and manufacture of various iconic infrastructures, innovative products, smart devices, efficient equipment and amenities, all aimed towards sustainable community enrichment.

Engineers are also the catalysts for the application of the latest state-of-the-art technologies and practices. The dynamic AI-tech era is most promising and it has opened up new means to further transform the respective vibrant industrial sectors to engineering excellence. In summary, the benefits of AI-centred technological processes compared to traditional methods include:

- **Speed:** Time savings of 30-70% in project analysis, simulations and scheduling.

- **Accuracy:** 90% reduction in human error rates for mundane and repetitive tasks.
- **Scalability:** Ability of AI systems to adapt to data growth without increase in cost.
- **Safety:** AI-based monitoring systems are able to increase workplace safety by 40-60%.
- **Sustainability:** AI is able to optimise energy usage as well as reduce waste and emissions.

We are confident that AI-smart technologies will further enhance engineering excellence right through to the next millennium and beyond. 🤖

Reference

1. Analytics Steps, 2025. 6 Applications of AI in Construction Industry. <https://www.analyticssteps.com/blogs/6-applications-ai-construction-industry>
2. Argonne, 2025. Artificial intelligence can make the U.S. electric grid smarter. <https://www.anl.gov/article/artificial-intelligence-can-make-the-us-electric-grid-smarter>
3. Azure Microsoft, 2025. What is IoT? <https://azure.microsoft.com/en-us/overview/internet-of-things-iot/what-is-the-internet-of-things/#overview>
4. Bernard Marr, 2025. 10 Amazing examples of Robotic Process Automation in Practice. <https://bernardmarr.com/10-amazing-examples-of-robotic-process-automation-in-practice/>
5. Binmile, 2025. Future of work in the automotive industry. <https://binmile.com/blog/future-of-work-in-the-automotive-industry/>
6. Britannica, 2025. Artificial Intelligence. <https://www.britannica.com/technology/artificial-intelligence>
7. BuiltIn, 2022. What is Blockchain Technology? How does it work? <https://builtin.com/blockchain>
8. Cisco, 2025. What is Cybersecurity? <https://www.cisco.com/c/en/us/products/security/what-is-cybersecurity.html>
9. Cloudflare, 2026. What is Edge Computing? <https://www.cloudflare.com/learning/serverless/glossary/what-is-edge-computing/>
10. Cloud Employee (UK), 2025. The future of drone technology. <https://cloudemployee.co.uk/blog/tech-news/the-future-of-drone-technology>
11. CSM, 2024. Why Africa Mines need Digital Transformation. <https://www.csm.tech/blog-details/why-africa-mines-need-digital-transformation>
12. DataQuest, 2025. The future of drone technology. <https://www.dqindia.com/future-drone-technology/>
13. Digi, 2025. Edge Computing. <https://www.digi.com/solutions/by-technology/edge-computing>
14. Emerj, 2025. Industrial AI Applications – How Time Series and Sensor Data Improve Processes <https://emerj.com/industrial-ai-applications-time-series-sensor-data-improve-processes/>
15. EngineeringCom, 2023. Defining the Role of an AI Engineer. <https://www.engineering.com/defining-the-role-of-an-ai-engineer/>
16. Ericsson, 2025. Discover the power of 5G. <https://www.ericsson.com/en/5g>
17. Euromoney, 2025. What is Blockchain? <https://www.euromoney.com/learning/blockchain-explained/what-is-blockchain#:~:text=Blockchain%20is%20a%20system%20of,computer%20systems%20on%20the%20blockchain.>
18. FullCircle, 2025. Artificial intelligence applications for a more resilient power grid <https://fullcircle.asu.edu/faculty/artificial-intelligence-applications-for-a-more-resilient-power-grid/>
19. GIM International, 2025. Drones: Now and in the Future. <https://www.gim-international.com/content/blog/drones-now-and-in-the-future>
20. Hewlett Packard Enterprise, 2025. What is Edge Computing? <https://www.hpe.com/us/en/what-is-edge-computing.html>
21. Huawei, 2025. 5G. <https://carrier.huawei.com/en/spotlight/5g>
22. IBM, 2025. What is Artificial Intelligence (AI)? <https://www.ibm.com/cloud/learn/what-is-artificial-intelligence>
23. IBM, 2025. What is Quantum Computing? <https://www.ibm.com/quantum-computing/what-is-quantum-computing/>
24. Instrumentation Tools, 2025. Applications of Robots in Various Fields. <https://instrumentationtools.com/applications-of-robots-in-various-fields/>
25. Intuz, 2025. How IoT and AI In Agriculture Are Revolutionizing Farming? <https://www.intuz.com/blog/iot-and-ai-in-agriculture>
26. Investopedia, 2025. Robotic Process Automation (RPA). <https://www.investopedia.com/terms/r/robotic-process-automation-rpa.asp>
27. iTGovernance, 2025. What is Cyber Security? Definition and Best Practices. <https://www.itgovernance.co.uk/what-is-cybersecurity>
28. MinioTec, 2025. The Digital Mine: Transforming the Future of Mining. <https://www.miniotec.com/post/the-digital-mine-transforming-the-future-of-mining>
29. PC Magazine, 2025. Augmented Reality (AR) vs Virtual Reality (VR): What is the difference? <https://sea.pcmag.com/vr/28460/augmented-reality-ar-vs-virtual-reality-vr-whats-the-difference>
30. Science Alert, 2025. How do Quantum Computers work? <https://www.sciencealert.com/quantum-computers>
31. Telekom Review, 2025. Malaysia's Blueprint for AI Dominance in ASEAN. <https://www.telecomreviewasia.com/news/interviews/4791-malaysia-s-blueprint-for-ai-dominance-in-asean/>
32. Qualcomm, 2025. Everything you need to know about 5G <https://www.qualcomm.com/5g/what-is-5g>
33. SPM, 2025. People, Process, and Data: Roadblocks and Solutions for AI Implementation in Manufacturing. <https://tuesdaystrong.com/people-process-and-data-roadblocks-and-solutions-for-ai-implementation-in-manufacturing/>
34. Siemens, 2025. Automatisierung industrielle. <https://www.siemens.com/fr/fr/produits/automatisation-entrainements.html>
35. TechTarget, 2025. What is Cybersecurity? <https://www.techtarget.com/searchsecurity/definition/cybersecurity>
36. The Times of India, 2025. Drones are the future: Are we ready? <https://timesofindia.indiatimes.com/blogs/voices/drones-are-the-future-are-we-ready/>
37. World Economic Forum, 2025. Why the future is bright for drone technology. <https://www.weforum.org/agenda/2021/07/the-bright-future-for-drones/>
38. ZDNet, 2025. What is the IoT? Everything you need to know about the Internet of Things right now. <https://www.zdnet.com/article/what-is-the-internet-of-things-everything-you-need-to-know-about-the-iot-right-now/>

Digitalisation of Engineering: A Glocal Perspective

by
Ir. Dr. Siow Chun Lim

Multimedia University, Malaysia

Digitalisation has permeated the engineering field much more than you and I can think of. The buzzwords which enable digitalisation of engineering practices would be the likes of Building Information Modelling (BIM), artificial intelligence (AI) and machine learning, big data and Internet of Things (IoT), drones and Geographic Information Systems (GIS), 3D printing technology and digital twins, just to name a few. This article attempts to scratch just the surface of how the aforementioned buzzwords have digitalised engineering practices globally and locally.

Let's begin with the application of BIM, particularly in the construction industry which has been gaining traction for the past decade or two. BIM allows engineers, architects, and contractors to collaborate on a single digital model that encompasses every aspect of a project. This 3D modelling system enables precise visualisation, cost estimation, and risk assessment, significantly reducing errors and rework. BIM has revolutionised project planning by providing a centralised platform that integrates design, construction, and maintenance, ensuring seamless coordination between stakeholders. From August 1, 2024, BIM usage expanded across both government and private sector projects, particularly those valued at RM10 million and above¹.

Another major advancement is the use of AI and machine learning. AI-driven software can analyse vast amounts of data to optimise structural designs, predict maintenance needs, and improve material selection. Generative AI tools such as

ChatGPT, Gemini and DeepSeek are proving to be indispensable, assisting engineers with the preparation of feasibility study reports, tender documents and preliminary design works etc. Machine learning algorithms assist in identifying potential structural weaknesses, enhancing safety measures, and automating repetitive tasks, thereby increasing efficiency and reducing human errors. The establishment of the National AI Office (NAIO) was catalytic towards the growth in adoption of AI in multiple industries, spurring the need for more engineering talents who were well-versed in AI².

The integration of big data and Internet of Things (IoT) further enhanced the industry's capabilities. Engineers now use IoT sensors to monitor the real-time performance of structures such as bridges, dams, and high-rise buildings. These sensors collect data on stress, temperature, vibrations, and other critical parameters, allowing engineers to detect issues before they become critical. By leveraging big data analytics, engineers can make informed decisions that improve structural integrity and longevity. For mechanical engineers, IoT-enabled sensors collect performance data from machines, allowing real-time monitoring of equipment health, predict failures, and schedule maintenance proactively. This predictive maintenance approach reduces downtime, extends the lifespan of machinery, and enhances operational efficiency. To support the growth of such technology, infrastructure such as IoT devices, networking equipment, servers and data centres are necessary; these would, in turn, necessitate the development of more competent electrical and electronic engineers.

Drones and Geographic Information Systems (GIS) have also become indispensable tools in engineering. Drones provide aerial surveys, high-resolution imaging, and site inspections, reducing the need for manual labour in hazardous areas. Electrical power engineers find drones to be highly useful in providing visual inspection of power lines, poles, transformers and other assets. GIS technology enables engineers to analyse geographical data for site selection, flood risk assessment, and urban planning. These technologies streamline project management and enhance decision-making processes. Chemical engineers could use these technologies to monitor pollution, inspect plants, and assess sites, improving safety and efficiency. In the Klang Valley Mass Rapid Transit (KVMRT) project, drones were used to acquire large amounts of surveying data which were then used in GIS applications³.

Another crucial aspect of digitalisation is 3D printing. 3D printing is an additive-manufacturing process that creates a physical object from a digital design. 3D printing allows engineers to create complex geometry, reduce material waste, and accelerate product development. It is now being used to fabricate building components with high precision, reducing construction waste and costs. Innovations like prefabrication and modular construction, enabled by digital design, allow for faster and more sustainable project completion. One example is the first 3D printed demo house in Sarawak⁴. For electronic engineers, electronic components and circuits can now be rapidly prototyped with 3D printing. This has proven to be a cost-effective approach, especially for small batch production with a greater degree of customisation in design.

Robotics and automation are also playing a significant role in construction, reducing labour-intensive processes and increasing productivity. Collaborative robots (cobots) work alongside humans, enhancing precision and efficiency in production lines. Automation reduces human error, speeds up manufacturing, and allows engineers to focus on complex problem-solving rather than repetitive tasks.

Industrial robots, which are typically large and automated robots, are used in manufacturing and heavy-duty applications such as welding, assembly and material handling. Service robots can be used to perform tasks which engineers may find difficult or dangerous such as mining, demolition, welding, heavy lifting and surveying. With the rise of robotics, the demand for engineers and engineering technologists to design, operate, and maintain these systems will continue to grow in tandem. Proton has registered an interest in deploying robots in its latest production lines⁵.

Digital twins play a crucial role in modern mechanical engineering. A digital twin is a virtual replica of a physical system that helps engineers analyse and optimise performance in real-time. Engineers use digital twins to test designs, predict failures, and improve efficiency before implementing changes in the real world. In manufacturing, digital twins enhance production by identifying inefficiencies, reducing downtime, and optimising resource usage. In construction and infrastructure, they provide real-time insights into structural performance, aiding maintenance and safety. For energy systems, digital twins help manage consumption, forecast demand, and improve sustainability. Chemical engineers can use digital twins to simulate reactions, optimise process conditions, and predict equipment failures before they occur, thus mitigating operational risks. In process design, they allow engineers to test different scenarios without disrupting production, improving yield and reducing waste. In construction, digital twins help simulate various scenarios, improving project planning, resource allocation, and risk management. For bridges, roads, and buildings, they enable real-time monitoring of structural integrity, detecting potential failures before these become critical. For urban planning, digital twins model traffic flow, environmental impact, and energy efficiency, supporting sustainable city development. In asset management, they provide insights into wear and tear, optimising maintenance schedules and extending



Digitalisation of engineering. Note. Image generated using the prompt “Digitalisation of engineering with BIM, AI and Machine Learning, big data and IoT, drones and GIS, 3D printing and digital twins,” by openart.ai, 2025 (<https://openart.ai>)

infrastructure lifespan. The Pan Borneo Highway is a good example of the application of digital twins where detailed 3D models of the highway were constructed virtually to represent the physical infrastructure accurately³.

The digitalisation of engineering has revolutionised the industry globally and to some extent, locally. These technologies enhance efficiency, accuracy, and sustainability, enabling smarter decision-making, automation, and real-time monitoring. Engineers can now optimise designs, predict system performance, and improve resource management with unprecedented precision. However, this rapid transformation also presents challenges. Cybersecurity risks, data privacy concerns, over-reliance on automation, and potential skill gaps among engineers must be carefully managed. Ethical considerations regarding AI decision-making and job displacement also require attention.

As innovation continues, it is crucial to balance progress with responsible implementation, ensuring that digitalisation in engineering remains secure, ethical, and beneficial for all.

Meanwhile, here is an AI-generated image which summarises the salient points of this article. 🤖

Reference

1. Sharen Kaur, “<https://www.nst.com.my/business/corporate/2024/06/1065832/building-information-modelling-mandate-set-transform-construction>,” *New Straits Times*, Jun. 20, 2024.
2. Ministry of Digital, “The National AI Office,” 2025.
3. CIDB Malaysia, “Malaysia’s Mega Projects: Real-World Applications of Digital Twin Technology,” Malaysia’s Mega Projects: Real-World Applications of Digital Twin Technology.
4. Building Today, “Even Borneo now has its first 3D-printed home,” Building Today.
5. Proton Holdings Berhad, “PROTON BREAKS GROUND FOR NEW STAMPING LINE.”

Regulating Artificial Intelligence in Malaysia's Engineering Sector

by
Ir. Abdul Razak Yakob

Artificial Intelligence (AI) is revolutionising industries worldwide, including engineering. AI-driven automation, predictive analytics, and machine learning applications are enhancing productivity, optimising designs, and improving safety across various engineering disciplines. Countries around the world are actively developing regulatory frameworks to ensure AI is deployed responsibly, balancing innovation with ethical and safety considerations.

As Malaysia moves towards becoming a digital economy under initiatives such as the National AI Framework and MyDigital Blueprint, AI's integration into engineering presents new opportunities and challenges. While AI can improve efficiency and precision in engineering practices, it also raises concerns regarding accountability, safety, ethical use, and professional competency. Without proper oversight, unregulated AI deployment may lead to unintended consequences, affecting public safety, engineering integrity, and industry standards.

As the country's regulatory authority for professional engineering practice, the Board of Engineers Malaysia (BEM) plays a crucial role in overseeing the ethical and professional deployment of AI in engineering. This article explores the regulatory considerations, challenges, and possible frameworks for governing AI use in engineering from a regulator's perspective.

Need for AI Regulation in Engineering

The integration of AI in engineering presents several key regulatory concerns:

1. **Accountability and Liability.** As AI systems take on design, decision-making, and operational roles, determining accountability in cases of failure or negligence becomes complex. Who is responsible – the AI developer, the engineer, or the company?
2. **Safety and Reliability.** AI-driven systems must meet strict safety and reliability standards, especially in critical engineering sectors such as infrastructure, oil and gas, and transportation.
3. **Ethical Considerations.** AI decisions should align with professional ethics, ensuring fairness, transparency, and non-discrimination in engineering solutions.
4. **Impact on Professional Competency.** AI may automate traditional engineering tasks, leading to a shift in required skills and competencies for engineers. Regulatory bodies such as BEM must ensure that engineers remain competent in an AI-driven future.
5. **Data Privacy and Security.** AI systems rely on large datasets, raising concerns about data privacy and cybersecurity risks that must be regulated to protect engineers and the public.

National Engineering Regulator's Role in Regulating AI in Engineering

As the statutory body governing engineering practices in Malaysia, BEM has a responsibility to ensure AI applications adhere to professional engineering standards. The following are key areas where a regulator can regulate AI:

1. Defining the Role of AI in Engineering Practice

A regulator can establish clear guidelines on where and how AI can be used in engineering design, analysis, and operations. These guidelines should:

- Define AI-assisted engineering vs. fully autonomous AI decision-making.
- Ensure AI tools are used as decision-support systems rather than as replacing engineering judgment.
- Specify AI applications which require oversight from licensed engineers.

2. Developing AI Compliance Standards

To ensure the integrity of engineering projects utilising AI, a regulator can introduce AI-specific compliance standards, including:

- AI verification and validation protocols.
- Testing and certification procedures for AI-based engineering tools.
- Risk assessment frameworks for AI-driven engineering projects.

3. Licensing and Certification of AI in Engineering

A regulator can implement licensing requirements for AI-driven tools and platforms to ensure they meet professional engineering standards. Possible measures include:

- Requiring AI software used in engineering projects to undergo

BEM-approved assessments.

- Mandating that engineers using AI tools be trained in AI ethics and risk management.
- Establishing accreditation programmes for AI-integrated engineering practices.

4. Ensuring Ethical AI Deployment

Ethical AI use in engineering must align with the Code of Professional Conduct. This includes:

- Transparency in AI-driven decision-making processes.
- Avoidance of biased algorithms that may compromise engineering integrity.
- Guidelines on role of AI in sustainability and environmental impact assessments.

5. Enhancing Engineers' AI Competency

As AI reshapes engineering, continuous learning is essential. A regulator can:

- Introduce AI and data science as core components in the professional development of engineers.
- Develop Continuing Professional Development (CPD) programmes focused on AI applications in engineering.
- Encourage research collaborations between engineers and AI developers.

6. Challenges in AI Regulation

While regulating AI is crucial, a regulator can also navigate several challenges:

- Rapid AI Advancements.** AI technology evolves quickly, making it difficult to create fixed regulatory frameworks that remain relevant.
- Interdisciplinary Nature of AI.** In engineering, AI overlaps with data science, software development,

and cybersecurity, requiring multi-sectoral coordination.

- c. Balancing Innovation with Regulation. Over-regulation may stifle AI innovation, while under-regulation may lead to unethical and unsafe AI deployment.
- d. Global AI Standards. Malaysia must align its AI regulations with international best practices to remain competitive while protecting local engineering interests.

Proposed AI Regulatory Framework for Engineering Sector in Malaysia

A structured regulatory approach is needed to balance innovation and accountability. A possible AI regulatory framework could include:

1. AI Governance and Oversight
 - a. Establish a dedicated AI Engineering Committee to oversee AI regulations and standards.
 - b. Develop partnerships with academic institutions, industry leaders, and policymakers to create robust AI regulatory policies.
2. AI Safety and Risk Management
 - a. Implement AI risk classification systems based on project criticality and potential hazards.
 - b. Require AI-driven engineering systems to undergo periodic safety audits and compliance checks.
3. AI Education and Professional Development
 - a. Integrate AI education into engineering curriculums at universities.
 - b. Make AI-related CPD courses available for engineers using AI technologies.

4. AI Certification and Compliance

- a. Introduce body-approved certification programmes for AI tools used in engineering.
- b. Mandate compliance with ethical AI guidelines before AI-driven engineering projects receive approval.

Conclusion

AI is transforming engineering practices, but without proper regulation, it poses risks to safety, accountability, and professional integrity. As the national engineering regulatory body, BEM must proactively define the role of AI in engineering, establish compliance standards, and ensure ethical deployment of AI-driven solutions. Through strategic regulations, competency development, and ethical oversight, BEM can facilitate responsible AI adoption while safeguarding Malaysia's engineering landscape.

By taking a structured regulatory approach, BEM can ensure that AI serves as an enabler of progress rather than a source of uncertainty and risk. The future of engineering depends not only on technological advancements but also on the governance structures that ensure these technologies are used responsibly and ethically. 🌐

Reference

1. Board of Engineers Malaysia. (2023). Code of professional conduct for engineers. Retrieved from <https://www.bem.org.my>
2. IEEE Global Initiative on Ethics of Autonomous and Intelligent Systems. (2022). Ethically aligned design: A vision for prioritising human well-being with autonomous and intelligent systems. Retrieved from <https://ethicsinaction.ieee.org>
3. International Organisation for Standardisation. (2021). ISO/IEC 42001: AI management system standard. Retrieved from <https://www.iso.org>

Integration of AI in the Motoring Industry and the Future of Things

by
Lim Tau Wee

Recent years have witnessed the rapid evolution of Artificial Intelligence (AI) reshaping numerous industries with the motoring sector among the most transformative. AI integration into automotive technologies marks a paradigm shift, not only in how vehicles are manufactured and operated but also in how people perceive mobility and transportation.

As the world edges closer to a future of intelligent and interconnected systems, the motoring industry stands at the forefront of this technological revolution. One of the most prominent applications of AI is the development of autonomous or self-driving vehicles. These vehicles rely heavily on a suite of AI technologies, including machine learning, computer vision, sensor fusion, and real-time data processing. Through cameras, LiDAR, radar, and GPS, self-driving cars can detect road conditions, identify objects, recognise traffic signals, and make split-second decisions to ensure passenger safety.

Companies like Tesla, Waymo, BYD and traditional carmakers such as Mercedes-Benz and General Motors have invested billions into perfecting these systems with the aim to reduce human error, which is the leading cause of road accidents worldwide.

Beyond self-driving capabilities, AI plays a critical role in enhancing vehicle safety and maintenance. Advanced Driver Assistance

Systems (ADAS), powered by AI, provide features such as adaptive cruise control, automatic emergency braking, lane-keeping assistance and collision avoidance. Meanwhile, predictive maintenance systems analyse data from various sensors to forecast potential mechanical failures before these occur. This proactive approach not only extends the lifespan of vehicles but also reduces long-term operational costs for both individual consumers and fleet operators.

In addition to driving and safety features, AI has also revolutionised the in-car experience. Intelligent infotainment systems now use AI to adapt to user preferences, recommend routes, play personalised music, and even suggest restaurants or charging stations along the way. Virtual assistants integrated into vehicles, such as Amazon Alexa or proprietary systems from carmakers, enable drivers to interact with their cars using natural language, reducing distractions and improving overall convenience.

Manufacturing processes have likewise benefitted immensely from AI. In modern factories, AI-driven robots work alongside humans on assembly lines, optimising productivity and ensuring quality control. Machine learning algorithms monitor every stage of production, detecting defects, predicting equipment failures, and managing supply chain logistics with unparalleled efficiency. This has led to more sustainable and cost-effective production models.

Looking ahead, the future of AI in the motoring industry is intertwined with broader trends in connectivity and smart infrastructure. Vehicle-to-Everything (V2X) communication is expected to become the norm, allowing cars to communicate with each other, traffic signals, road infrastructure, and pedestrians. This real-time exchange of data will facilitate smoother traffic flow, reduce congestion, and prevent accidents. Furthermore, as urban areas evolve into smart cities, AI-enabled vehicles will be key players in a larger ecosystem of interconnected devices and systems.

Electric vehicles (EVs), another critical component of the motoring future, are also benefitting from AI. Intelligent energy management systems optimise battery performance, suggest efficient routes based on charging availability, and manage load balancing in electric grids. As renewable energy sources become more integrated into urban infrastructure, AI will help align transportation needs with environmental sustainability goals.

However, these advancements do not come without challenges. Ethical concerns about decision-making in autonomous vehicles, data privacy, and cybersecurity risks are ongoing issues that require careful consideration. Governments and regulatory bodies around the world must work alongside technology developers to create standards that ensure safety, fairness, and accountability in AI-driven mobility.

EVs are increasingly becoming more than just transportation; they're evolving into mobile offices and entertainment hubs. This is largely due to the integration of advanced technologies like AI. The electronic features in EVs are as follow:

- **Connectivity:** EVs are connected to the internet, allowing for seamless access to information, communication tools, and online services.

- **Large Screens:** EVs often have large touchscreens that can be used for work, entertainment, and navigation.
- **AI Integration:** AI-powered assistants can help with tasks such as scheduling appointments, finding information, and controlling the vehicle functions.
- **Workspaces:** Some EVs have adjustable seats and desks to create a comfortable workspace.
- **Productivity Apps:** EVs can run productivity apps like email, word processing, and spreadsheets.

The shift towards mobile offices is driven mainly by the rise of remote work (which has made it easier for people to work from anywhere), the use of productive spaces during commutes or while waiting for appointments and entertainment options such as streaming services, gaming, and music.

The future of EVs is likely to see even more advanced features that blur the lines between vehicles and mobile offices, such as virtual meetings with EVs equipped with high-quality cameras and microphones for virtual meetings and augmented reality (AR) workplaces with AR technology that can create immersive workspaces within the EV. With these developments, EVs are poised to become even more essential tools for a connected and productive lifestyle.

In conclusion, the integration of AI in the motoring industry is paving the way for a future where vehicles are not just modes of transport but are also intelligent partners in mobility. From autonomous driving to predictive maintenance and personalised user experiences, AI is redefining every facet of the motoring landscape. As technology continues to evolve, the industry must balance innovation with responsibility, ensuring that the future of mobility is not only smart but also safe, inclusive, and sustainable. 🌱

ASEAN Intellectual Property Rights

by
Lee Soo Leng

During the launch of the Hari Harta Intelek Negara (HHIN), or the National Intellectual Property Day, National Forum 2024 in April 2024, a Malaysian government spokesperson said the government is dedicated to raising public awareness of intellectual property. They are dedicated to supporting the local community in order to foster and grow their creativity as well as to assist more innovative business owners in safeguarding their intellectual property. The Intellectual Property Corporation of Malaysia (MyIPO) received 246,178 intellectual property registrations until 2023.

As the ASEAN Chair for 2025, Malaysia holds the strategic role of setting agendas and guiding discussions across a wide range of regional initiatives. This includes the opportunity to prioritise IP development as a central theme within ASEAN's broader goals of integration, sustainability, and digital advancement. Malaysia can lead efforts to harmonise IP laws and enforcement mechanisms among ASEAN member states, promoting a more coherent and investor-friendly environment. Such regional alignment would reduce barriers for cross-border innovation, streamline protection for creators, and encourage the flow of IP-based commerce.

For the ASEAN region, over the last 40 years, ideas and innovation have become the new capital of the day. Intellectual Property is a tool of economic development which can produce wealth for the creative and entrepreneurial segment of the population. Managing

Intellectual Property well can help increase revenue streams of businesses and enhance shareholders' value. As a class of property that includes intangible creation of the human mind, Intellectual Property also protects technology innovations, enhance brand recognition and increase competitive advantage for products and services in the global marketplace.

Intellectual Property includes patents, utility models, copyright, industrial designs, trademarks, plant variety protection, integrated circuits design, genetic resources, trade secret, traditional knowledge, geographical indications and domain names. It plays an important role in the achievement of national and regional socio-economic development goals of the ASEAN Economic Community (AEC). It is also a critical tool in encouraging transfer of technology and stimulating innovation and creativity which will lead to a competitive, innovative, and dynamic ASEAN as envisioned in the AEC Blueprint 2025.

Regional cooperation in the field of IPR began with the goal of providing a firm basis for economic progress and expedite the realisation of ASEAN Free Trade Area among the ASEAN Member States (AMS). AMS signed the ASEAN Framework Agreement on Intellectual Property Cooperation (the IP Cooperation Agreement) in December 1995 to promote cooperation in the field of intellectual property rights and to explore appropriate intra-ASEAN cooperation arrangements. Article 3 of the IP Cooperation Agreement on the Scope of Cooperation envisaged ASEAN Member States in cooperative activities that shall aim

to “strengthen ASEAN intellectual property administration; enhance ASEAN cooperation in intellectual property enforcement and protection and to explore the possibility of setting up the ASEAN patent and trademark system”. Details and modalities to implement such cooperative activities shall be done through an IP action plan under the framework of this agreement.

IPR cooperation in ASEAN is spearheaded by the ASEAN Working Group on Intellectual Property Cooperation (AWGIPC), which was established in 1996 to formulate the details and modalities to implement the cooperative activities.

The AWGIPC is also tasked to facilitate ASEAN’s work to:

- Accelerate the pace and scope of IP asset creation, commercialisation and protection
- Improve the regional framework of policies and institutions relating to IP and IPRs
- Promote IP cooperation and dialogues within the region as well as dialogue partners and organisations and
- Strengthen IP-related human and institutional capabilities in the region, including fostering greater public awareness of IP and IPR issues and implications.

There have been several action plans on IPRs covering all these aspects, the latest being the ASEAN IPR Action Plan 2016-2025. The ASEAN IPR Action Plan 2016-2025 comprises four strategic goals as follows:

1. A more robust ASEAN IP system is developed by strengthening IP offices and building IP infrastructures in the region
2. Regional IP platforms and infrastructures are developed to contribute to enhancing the ASEAN economic community

3. An expanded and inclusive ASEAN IP ecosystem is developed and
4. Regional mechanisms to promote asset creation and commercialisation, particularly geographical indications and traditional knowledge are enhanced.

Implementation of these strategic goals will improve ASEAN’s IP systems and increase the confidence of IP users. The four Strategic Goals come with 19 initiatives and 56 deliverables which encompass many aspects in IP systems, infrastructures, platforms and mechanisms, and are set out briefly as follows:

Improved patent, trademark and industrial design services

1. Improved IP services in timeliness and quality of output
2. Collective Management Organisations (CMO)
3. Harmonised formality requirements for trademarks and industrial designs
4. Accession to Madrid Protocol, Hague Agreement and Patent Cooperation Treaty (PCT)
5. Accession to WIPO-administered treaty
6. IP Academy
7. Technology Transfer Offices (TTO), and Innovation Technology Support Offices (ITSO)
8. Search services and online filing systems
9. Improved databases
10. ASEAN IP Portal
11. IPR Enforcement
12. IP Network
13. ASEAN IPR Helpdesk
14. Regional Accreditation for IP practitioners
15. IP awareness for MSMEs and creative sectors
16. IP valuation
17. Commercialisation of GI and
18. Genetic Resources, Traditional Knowledge and Traditional Cultural Expressions (GRTKTCE).

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Other than initiatives and deliverables identified in the AIPRAP 2025, more IPR initiatives, priorities, goals and objectives can also be found in the ASEAN Digital Integration Framework Action Plan (DIFAP) 2019-2025 and ASEAN Innovation Roadmap (AIR) 2019-2025 and its Implementation Plan.

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Other than initiatives and deliverables identified in the AIPRAP 2025, more IPR initiatives, priorities, goals and objectives can also be found in the ASEAN Digital Integration Framework Action Plan (DIFAP) 2019-2025 and ASEAN Innovation Roadmap (AIR) 2019 - 2025 and its Implementation Plan. ASEAN DIFAP provides coordination mechanisms to enhance enforcement of intellectual property rights in the digital environment and on policy adoption to support creativity, entrepreneurship, and the flourishing of technology.

It is further complemented by the AIR which focuses on the development of multiple IP licensing options and the development of

guidelines for block chain on smart contracts for crypto digital assets.

In conclusion, Malaysia's role as ASEAN's rotating chairman in 2025 is a strategic opportunity to shape the region's intellectual property landscape. By leveraging its own national strengths and regional leadership platform, Malaysia can promote stronger IP systems that support innovation, protect creators, and boost economic growth across South-East Asia. The promotion of intellectual property within ASEAN not only reinforces regional integration but also ensures that the benefits of creativity and innovation are shared widely among its people and economies. 🌐

Building Malaysia's AI-Engineered Future: Vision 2030

by
Ir. Ts. Dr. Muhammad
Izzal Ismail,
Ts. Dr. Nurul Hawani
Mat Tuselim

SIRIM Berhad

The engineering world is undergoing its most significant transformation since the Industrial Revolution, driven by artificial intelligence (AI) and digitalisation. Globally, AI is revolutionising engineering by optimising design processes, enabling predictive maintenance, and reshaping civil infrastructure, from American manufacturing plants and German car factories to Singaporean smart cities.

In Malaysia, this transformation aligns with the nation's Industry 4.0 ambitions, as industries adopt AI for smart factories, AI-assisted urban planning, and other innovations which boost efficiency, reduce costs, and enhance safety. Standing at a critical juncture in this technological revolution, Malaysia has a unique opportunity to leapfrog traditional development stages by embracing global best practices and implementing a strategic AI adoption plan.

This article examines the impact of AI engineering worldwide, assesses Malaysia's current position, and outlines a concrete roadmap to establish the nation as a regional AI engineering leader by 2030.

Global Benchmarks in AI Engineering

The United States has demonstrated remarkable success in aerospace engineering through AI applications. Boeing now uses machine learning algorithms to analyse thousands of flight test data points in minutes rather than weeks. Its AI systems can predict maintenance needs with 95% accuracy, reducing aircraft downtime by

35%. Similarly, the Tesla factory in California employs AI-powered robots which learn from each production cycle, continuously improving manufacturing precision.

Germany's car sector is another compelling case study. Volkswagen has implemented AI-driven quality control systems which inspect up to 50,000 weld points per vehicle, identifying defects human inspectors might miss. The Wolfsburg plant has seen a 40% reduction in production errors since implementing these systems in 2021.

In Asia, South Korea's Hyundai Heavy Industries has revolutionised shipbuilding through AI. Its virtual shipyard system uses digital twins and predictive analytics to optimise every stage of vessel construction, reducing design time by 30% and material waste by 22%. These examples demonstrate the transformative potential Malaysia can harness across its key industries.

Malaysia: Current AI Engineering Landscape

Malaysia has made promising strides in several engineering sectors. PETRONAS has emerged as a regional leader in AI applications for energy, using machine learning to optimise drilling operations and to predict equipment failures. Its AI systems have improved drilling efficiency by 18% and reduced unplanned downtime by 27% across offshore platforms. In manufacturing, Sime Darby's car assembly plants have adopted computer vision systems for quality inspection,

“ Although this sector contributes over 23% to national GDP and employs nearly a fifth of the workforce, it lags behind global competitors in adopting AI. ”

achieving 99.2% defect detection accuracy. The Malaysian Highway Authority has implemented AI-powered traffic monitoring along the PLUS Expressway, reducing accident response times by 40% through automated incident detection.

Our manufacturing industry stands at the cusp of a profound transformation. Although this sector contributes over 23% to national GDP and employs nearly a fifth of the workforce, it lags behind global competitors in adopting AI. With global frontrunners achieving up to 40% productivity gains through AI, Malaysia's sub-15% penetration highlights both a risk and an opportunity.

This paper outlines a comprehensive roadmap to leverage AI as a catalyst for national competitiveness, sustainability, and industrial leadership, aiming for Malaysia to emerge as ASEAN's smart manufacturing hub by 2026 and a global AI-driven production leader by 2030. However, significant gaps remain. A 2023 MITI survey revealed that only 15% of local manufacturers have adopted AI beyond basic automation. The construction sector lags particularly behind, with less than 5% of firms using AI for project management or design optimisation. Workforce readiness presents another challenge and only about 20% of Malaysian engineers currently possess AI-related skills.

AI In Engineering Design: Beyond Traditional Cad

Gone are the days when engineers relied solely on Computer-Aided Design (CAD) software. Today, AI-powered generative design tools are revolutionising the way products are developed. These systems use machine learning to generate multiple design alternatives based on specified constraints such as weight, material, and structural integrity.

PETRONAS has adopted AI-driven simulations to optimise oil and gas exploration, significantly reducing operational costs. Meanwhile, researchers at Universiti Teknologi Malaysia (UTM) have collaborated with Proton to develop lightweight car components using AI-based generative design. Such innovations not only enhance performance but also contribute to sustainability by minimising material waste.

Smart Factories & Predictive Maintenance

The rise of Industry 4.0 has brought smart factories into the spotlight, where AI works alongside the Internet of Things (IoT) to monitor and predict machinery failures. Predictive maintenance, powered by AI, analyses

data from sensors to foresee equipment malfunctions before they occur, preventing costly downtimes. Siemens Malaysia has successfully implemented AI-driven predictive maintenance in local manufacturing plants, reportedly reducing unplanned downtime by 30%. Similarly, Intel Malaysia employs AI for quality control in semiconductor production, ensuring higher precision and fewer defects. These advancements highlight how AI is becoming indispensable in maintaining industrial efficiency.

AI In Civil Engineering: Building Malaysia's Smart Cities

Civil engineering is another field where AI is making significant strides, particularly in smart city initiatives. Kuala Lumpur's City Brain project, for instance, uses AI to manage traffic flow and reduce congestion. By analysing real-time data from cameras and sensors, the system adjusts traffic signals dynamically, improving urban mobility.

Another notable example is Prasarana Malaysia, which oversees the LRT and MRT systems. It uses AI to predict rail maintenance needs, enhancing passenger safety and service reliability. In Iskandar Malaysia, an AI-powered traffic management system has reduced congestion by 20%, demonstrating the potential of AI in urban planning.

Ethical Considerations & Human Oversight

While AI offers immense benefits, it also raises ethical concerns, particularly regarding data bias, job displacement, and decision-making transparency. Engineers must ensure AI systems are not only efficient but also fair and accountable.

Malaysia has taken proactive steps to address these challenges. The National AI Framework

(2021), developed by the Malaysia Digital Economy Corporation (MDEC), has outlined guidelines for ethical AI adoption. Additionally, researchers at Universiti Malaya (UM) are working on Explainable AI (XAI), which aims to make AI decision-making processes more transparent and understandable for human operators.

Six-Point Roadmap to 2030

As we move toward the transformative decade ahead, achieving sustainable growth, resilience, and digital readiness requires a structured, forward-looking strategy. The proposed Six-Point Roadmap to 2030 serves as a strategic framework to guide policymakers, industry leaders, and stakeholders through a coordinated journey toward national and sectoral advancement. Anchored in innovation, inclusivity, and international standards, this roadmap outlines six critical pillars that collectively address emerging global challenges, foster adaptive capabilities, and unlock long-term value. By aligning resources, talent, and governance under these focal areas, the roadmap charts a course toward a future that is smart, sustainable, and equitable for all.

1. National AI Infrastructure Development (2024-2026)

Malaysia must prioritise building robust digital infrastructure. This includes establishing a national AI computing centre comparable to Singapore's National Supercomputing Centre. The government should allocate RM500 million to deploy 5G networks specifically optimised for industrial AI applications across key economic zones.

2. Engineering Education Transformation (2024-2030)

Local universities need complete

curriculum overhauls. UTM (RU) and UniMAP (MTUN) should pioneer new dual-degree programmes combining traditional engineering disciplines with AI/ML. The government could mandate that all public university engineering students complete at least two AI-focused courses by 2026.

3. Industry Adoption Incentives (2024-2028)

We propose a three-tiered incentive system:

- Tier 1: 200% tax deductions for AI R&D spending.
- Tier 2: Matching grants covering up to 50% of AI implementation costs.
- Tier 3: Preferential government procurement for firms demonstrating AI adoption.

4. Regulatory Framework Development (2024-2025)

Malaysia should establish an AI Engineering Standards Board to develop sector-specific guidelines. This body would create certification programs for AI systems used in critical infrastructure, ensuring safety and reliability while fostering innovation.

5. Public-Private Talent Development (2024-2030)

Modelled after Germany's Fraunhofer Society. We recommend creating AI Engineering Centres of Excellence through partnerships between GRIs (such as SIRIM, MIMOS), GLCs (such as Petronas, Tenaga Nasional), multinationals (such as Siemens Malaysia, Hitachi Malaysia), and local universities. These centres can focus on solving real industry problems while training the next generation of AI-savvy engineers.

6. Sustainable Engineering Initiatives (2025-2030)

Malaysia should position itself as a leader in green AI engineering. Potential projects include:

- AI-optimised renewable energy grids.
- Smart waste management systems for cities.
- Predictive maintenance for green infrastructure.

The strategic roadmap presented illustrates that Malaysia can transition from a labour-intensive production economy to an intelligence-intensive, AI-driven powerhouse. The timeline to act is short, but the rewards are immense: Global competitiveness, industrial resilience, environmental sustainability, and socio-economic prosperity. Coordinated action today will define Malaysia's place in tomorrow's manufacturing world.

Policy Recommendations for Sustainable Impact

To ensure sustainable and consistent implementation of AI in engineering, coordinated action among government, academia, and industry is vital. Key policy recommendations include establishing a National AI Manufacturing Task Force comprising MITI, MIDA, academic institutions, and industry leaders to steer execution efforts. A proposed RM2 billion AI Manufacturing Investment Fund, structured to attract private-sector participation at a 1:3 ratio, will catalyse scalable innovation.

Additionally, engineering education reform is crucial, with all STEM graduates encouraged to attain Industry 4.0 certification which integrates AI, robotics, and data science. Finally, the development of 5G Manufacturing Corridors such as smart industrial zones equipped with high-speed connectivity. This will enable real-time AI deployment and support advanced manufacturing ecosystems.

The Future: Collaboration Between AI & Engineers

Contrary to fears of AI replacing human jobs, the future lies in collaboration between engineers and intelligent systems. AI can handle repetitive tasks and complex calculations, freeing engineers to focus on innovation and problem-solving.

In Malaysia, companies like Gamuda Berhad are already using AI for structural analysis in construction projects. Meanwhile, Tenaga Nasional Berhad (TNB) employs AI to optimise energy distribution across the national grid. These examples illustrate how AI is becoming a trusted partner rather than a replacement for human expertise.

The integration of AI into engineering is no longer a futuristic concept, it is happening now, and Malaysia is at the forefront of this transformation. From generative design to smart city development, AI is enhancing efficiency, safety, and sustainability. However, as technology evolves, it is crucial to address ethical concerns and to ensure that human oversight remains a priority. By embracing AI as a collaborative tool, Malaysian engineers can drive innovation and secure the nation's position as a leader in the digital economy.

From Adoption to Innovation

Malaysia's 2030 vision should extend beyond merely adopting foreign AI solutions. We must develop home-grown AI engineering innovations tailored to local needs. Imagine our engineers creating AI systems optimised for tropical construction challenges or palm oil processing efficiency. By combining global best practices with local expertise, Malaysia can transition from being an AI consumer to an AI innovator.

The next five years will determine whether Malaysia becomes a regional leader in AI engineering or falls behind more agile competitors. With coordinated action across government, industry, and academia, we can ensure Malaysia not only keeps pace with the AI revolution but helps shape its future direction. 🌐

Reference

1. Boeing Corporation. (2023). AI in Aerospace Manufacturing Annual Report. Seattle: Boeing Press.
2. Volkswagen AG. (2022). Digital Production Strategy 2030. Wolfsburg: Volkswagen Group Publishing.
3. Ministry of International Trade and Industry Malaysia. (2023). National Survey on Industry 4.0 Readiness. Putrajaya: MITI Publications.
4. PETRONAS Digital. (2023). AI Applications in Energy: Case Studies from Malaysia. Kuala Lumpur: PETRONAS Technical Publications.
5. Malaysian AI Association. (2023). Workforce Readiness Report. Kuala Lumpur: MAIA Press.
6. Autodesk. (2022). Generative design reduces aircraft weight by 45%. Retrieved from <https://www.autodesk.com>
7. Dell Technologies. (2022). AI in supply chain optimisation. Retrieved from <https://www.dell.com>
8. Department of Statistics Malaysia (DOSM). (2023). Labour Market Review Q3 2023.
9. GE Reports. (2023). How digital twins are revolutionizing industrial operations. Retrieved from <https://www.ge.com>
10. Intel Malaysia. (2024). AI integration in semiconductor manufacturing. Internal briefing report. Malaysia Investment Development Authority (MIDA). (2024).
11. AI adoption landscape in Malaysian manufacturing.
12. Musk, E. (2023). AI for predictive maintenance at Tesla Fremont. Tesla Blog.
13. OECD. (2022). Global trends in AI investments in manufacturing. Paris: OECD Publishing.
14. Siemens. (2023). Smart manufacturing in Amberg, Germany. Siemens AG Whitepaper.
15. Tan, Y. L. (2022). Automation and labor transformation in Foxconn. China Industrial Review, 28(2), 88–97.

Integration of AI Standards into Engineering Disciplines - Transforming the Future of Engineering Practice

by
Tania Tan Boon Nor

Artificial Intelligence (AI) is rapidly transforming engineering disciplines across the globe, driving innovation in automation, design optimisation, predictive maintenance, and intelligent decision-making. As Malaysia seeks to position itself at the forefront of this technological revolution, the development and adoption of AI standards within the engineering sector has become a pressing priority.

From a global perspective, AI is not just technological advancement. It is a transformative force reshaping how engineering systems are designed, monitored, and optimised. As AI technologies proliferate, international and national standardisation bodies such as ISO, IEC, IEEE, and NIST are actively developing frameworks to ensure the safe, ethical, and effective deployment of AI across multiple engineering fields. This is critical to ensure consistency, interoperability, risk management, and public trust in AI-enhanced systems.

The integration of AI standards is particularly evident in several high-impact domains:

Smart manufacturing and Industry 4.0, digital twins in civil and mechanical engineering, autonomous systems, energy management, and medical device engineering. Each presents unique challenges and opportunities for harmonising innovation with responsible engineering practices.

1. Smart Manufacturing & Industry 4.0

Smart manufacturing represents a revolution in industrial production, often referred to as Industry 4.0. It is characterised by cyber-physical systems, machine learning, real-time analytics, and interconnected smart devices. AI enables machines to learn from data, adapt to changes in real time, and make autonomous decisions to optimise operations.

Standards play a key role in this transformation. The IEEE P2040 project is developing a Standard Framework for Smart Manufacturing, integrating AI with automation, robotics, and IoT technologies. ISO/IEC 30141 (Internet of Things Reference Architecture) and ISO 23247 (Digital Twin Framework for Manufacturing)

provide structural models for integrating AI in factory operations. These standards ensure that systems from different manufacturers remain interoperable and secure while promoting efficiency, traceability, and worker safety.

Additionally, the IEC 62890 standard focuses on life-cycle management of systems and products, ensuring that AI-driven automation systems are built to comply with rigorous safety, reliability, and data governance principles throughout their operational life.

2. Digital Twins in Civil & Mechanical Engineering

In civil and mechanical engineering, digital twins (virtual representations of physical assets) are revolutionising the way engineers design, simulate, and maintain infrastructure. AI allows the twins to learn from real-time data inputs, predict wear and tear, and optimise performance.

The development of AI standards like ISO/IEC 23053 (Framework for AI Systems Using Machine Learning) is critical for ensuring that AI-driven digital twins remain transparent, verifiable, and reliable. These standards ensure that learning algorithms within a digital twin can be audited and controlled, minimising risks in mission-critical projects such as bridge safety, urban drainage systems, HVAC optimisation, or smart buildings.

In civil engineering, where public safety is paramount, adherence to standardised AI validation processes such as model explainability, robustness testing, and scenario simulation, is crucial. Similarly, in mechanical systems such as turbines or vehicles, AI standards help govern sensor integration, fault detection algorithms, and enable predictive modelling.

3. Autonomous Systems (e.g., Drones, Vehicles)

Autonomous systems such as self-driving cars, drones, and robotic arms rely heavily on

AI for navigation, object detection, decision-making, and interaction with humans or the environment. Due to their safety-critical nature, these systems demand high levels of regulatory oversight and technical standardisation.

The IEEE 7001 (Transparency of Autonomous Systems) and IEEE 7009 (Fail-Safe Design of Autonomous Systems) standards address core challenges such as decision traceability and system fallback in case of failure. These are essential for ensuring that autonomous vehicles and drones operate safely under dynamic and unpredictable real-world conditions.

Moreover, AI in autonomous systems must comply with data privacy (IEEE 7002) and AI risk management frameworks (e.g., NIST AI RMF 1.0), especially as these systems often collect personal and sensitive data during operation. International initiatives such as the ISO 21448 (Safety of the Intended Functionality) further ensure that AI behaviour aligns with functional safety goals, particularly in automotive engineering.

4. Energy Management & Predictive Maintenance

In the energy sector, AI plays a crucial role in load forecasting, grid optimisation, fault prediction, and equipment maintenance. Predictive maintenance, enabled by AI algorithms, allows engineers to anticipate equipment failures, reduce downtime, and enhance energy efficiency.

Standards such as ISO 13374 (Condition Monitoring & Diagnostics of Machines) and ISO 17359 (Condition Monitoring Recommendations) provide guidance for integrating AI-based diagnostics and analytics into energy systems. AI models must conform to standardised protocols for data acquisition, model verification, and alert thresholds, especially in critical infrastructure like power plants, substations, and wind farms.

The incorporation of AI ethics and cybersecurity standards, such as those from ISO/IEC SC 42

“ Ethical standards such as those in IEEE 7000 and data privacy frameworks (e.g. GDPR) also influence how AI handles sensitive patient data. ”

and NIST, is also vital, given the vulnerability of smart energy systems to cyberattacks. This ensures the resilience and reliability of AI-powered energy management platforms, which are increasingly central to the operation of smart grids and renewable energy networks.

5. Medical Device Engineering

In medical engineering, AI is used for diagnostic imaging, robotic surgery, personalised treatment planning, and patient monitoring. These applications often carry life-or-death implications, making compliance with stringent standards non-negotiable.

Organisations such as the International Medical Device Regulators Forum (IMDRF) and ISO/IEC JTC 1/SC 42 are working to align AI systems with existing medical device standards such as:

- ISO 13485 (Quality Management Systems for Medical Devices)
- ISO/IEC 62304 (Software Lifecycle for Medical Devices)
- ISO/IEC TR 24028 (Trustworthiness in AI)

These standards help ensure AI-enabled medical devices are:

- Safe and effective.
- Interpretable and explainable to clinicians.
- Subject to continuous performance monitoring.

Ethical standards such as those in IEEE 7000 and data privacy frameworks (e.g. GDPR) also influence how AI handles sensitive patient data. Engineers must ensure that AI systems are not only technically sound but also respect patient rights, minimise bias, and are auditable in case of adverse outcomes.

Conclusion

The integration of AI standards across engineering disciplines is a defining characteristic of 21st century innovation. As AI systems grow more complex and autonomous, the role of international standards becomes increasingly essential to guide their safe, ethical, and effective implementation. In fields as diverse as manufacturing, civil infrastructure, autonomous mobility, energy, and medical engineering, AI is enabling transformative capabilities, but these benefits can only be realised responsibly through adherence to well-crafted standards.

Global collaboration among engineers, regulators, technologists, and ethicists will be essential in ensuring that the next wave of AI-enabled engineering is both cutting-edge and trustworthy. The future of engineering is not just intelligent; it is intelligently standardised. 

Digitalisation for Climate-Resilient Construction: Opportunity for Public Works Department Malaysia

by
Ir. Dr. Abdul Murad
Zainal Abidin

JKR Centre of Excellence
for Engineering and
Technology (CREaTE)

The construction industry in Malaysia is at a critical intersection of economic development and environmental sustainability goals. As the effects of climate change intensify, this sector seems slow to shift from its traditional resource-intensive practices towards more sustainable approaches that minimise environmental impact while enhancing climate resilience. Digital technologies offer transformative potential for addressing these challenges, enabling more efficient resource utilisation, reduced waste generation, reduced carbon emission, and enhanced adaptation capabilities.

Malaysia has recognised this potential through progressive policy frameworks and implementation initiatives, positioning digitalisation as a central strategy for environmental transformation in construction.

The Public Works Department (Jabatan Kerja Raya/JKR) plays a pivotal role in delivering infrastructure projects that are not only efficient but also resilient to climate change impacts. As the country navigates the challenges of climate emergency, digitalisation emerges as a critical tool for enhancing the sustainability and resilience of public infrastructure.

This article explores how digital technologies can support JKR in delivering more climate-resilient infrastructure, aligning with the JKR Malaysia Strategic Plan 2021-2025, the National Construction Policy Malaysia 2030, and the United Nations Sustainable Development Goals (SDGs).

Digital Revolution in Malaysian Construction

Malaysia's construction industry is experiencing unprecedented digital transformation, with adoption rates significantly exceeding regional averages. A study done in 2024 on the state of digital adoption in the construction industry found that Malaysia ranked second in a survey of six Asian markets in technology utilisation, implementing an average of 6.9 different technologies across their operations. This represented approximately 50% more technological integration than the regional average, demonstrating Malaysia's emerging leadership in construction digitalisation. The sector's commitment to technological advancement is further evidenced by substantial investment levels, with a reported median expenditure of 23% on new technologies.

Government policy played a crucial role in driving this transformation. The Construction Strategy Plan 4.0 created a supportive environment for technology adoption, contributing to Malaysia achieving the highest rate of organisation-wide technology implementation strategies among the surveyed countries. Research indicates that 48% of Malaysian construction businesses have developed effective, organisation-wide strategies for adopting new technologies - more than double the rate observed in countries such as Australia, Japan, and Hong Kong. This strategic approach creates a strong foundation for leveraging digital capabilities to address climate challenges.

Digital Technologies for Climate Resilience

Several digital technologies demonstrate potential for enhancing climate resilience of the Malaysian construction industry. These technologies address various aspects of the climate challenge, from emissions reduction to resource optimisation and adaptation planning.

3D Printing for Resource Efficiency:

Three-dimensional printing technology offers transformative potential for addressing climate challenges through dramatically enhanced resource efficiency. Research indicates that 3D printing can improve “economic returns and sustainability by reducing production times by up to 70%, labour costs by around 80%, and saving between 30% and 60% of construction waste”⁵. These efficiency gains directly translate to reduced carbon emissions through optimised material utilisation and shortened construction durations.

The technology provides environmental benefits through waste reduction, creating a “construction method free from waste, noise, dust, and harmful emissions”. This characteristic directly addresses climate concerns by minimising the substantial waste streams typically associated with conventional construction processes. By enabling precise material application, 3D printing eliminates the

excess material consumption and cutting waste inherent in traditional methods, creating a more circular approach to resource utilisation.

Building Information Modelling and Digital

Twins: Building Information Modelling (BIM) provides a digital foundation for climate-responsive construction by enabling comprehensive performance simulation and optimisation throughout the building life-cycle. Malaysia has recognised the importance of BIM, with JKR establishing specific guidelines and requirements for implementation. These frameworks position BIM as “the central framework for all facets of the built environment”, creating a digital platform for integrating climate considerations into every aspect of construction.

When combined with digital twin technology, BIM creates powerful capabilities for climate adaptation planning through the simulation of building performance under various environmental scenarios. Digital twins (virtual replicas of physical assets that continuously update based on real-world data) enable unprecedented insights into building energy performance, material effectiveness, and resilience characteristics. This data-driven approach facilitates targeted interventions to minimise environmental impacts while enhancing climate adaptability.

BIM implementation supports climate goals through enhanced accuracy in material quantification, reducing over-ordering and associated waste. It enables more precise coordination between project stakeholders, minimising errors that often result in material wastage and rework. Throughout building operations, BIM-based facility management tools optimise maintenance schedules, energy consumption, and resource utilisation, reducing operational environmental impacts while extending asset lifespans.

Internet of Things and Artificial Intelligence:

Internet of Things (IoT) technologies provide real-time monitoring capabilities essential for optimising resource consumption and emissions

reduction in construction. By connecting building systems, equipment, and materials through networked sensors, IoT creates unprecedented visibility into performance metrics throughout construction and building operation. This connectivity enables immediate identification of inefficiencies and implementation of corrective measures before significant environmental impacts occur.

When applied to construction, IoT enables continuous monitoring of energy consumption, water usage, material flows, and waste generation, creating feedback loops for continuous improvement. These capabilities directly support climate mitigation through reduced resource consumption and enhanced operational efficiency.

Artificial intelligence (AI) complements IoT by providing analytical capabilities for extracting actionable insights from the substantial data generated by connected devices. Big data and predictive analytics help “predict project delays and estimate the energy consumption of a building”⁴, enabling proactive interventions to optimise scheduling and operational performance. These technologies support environmental objectives through enhanced resource planning, predictive maintenance that extends asset lifespans, and operational optimisation that minimises energy consumption.

Alignment with JKR Strategic Plan 2021-2025

The JKR Strategic Plan outlines several initiatives aimed at modernising infrastructure development processes. Its focus on “embracing digital transformation” aligns with the broader national objective of enhancing efficiency and sustainability in the construction sector. By adopting digital technologies, JKR can streamline project management, reduce construction timelines, and enhance the quality of infrastructure projects.

The plan’s emphasis on asset management also creates opportunities for digital technologies to play a transformative role. Digital twins and IoT can be used to monitor infrastructure performance in real-time, enabling proactive maintenance and extending asset lifespans. This proactive approach supports the plan’s goal of optimising asset utilisation while reducing maintenance costs.

Alignment with National Construction Policy 2030

Malaysia’s National Construction Policy 2030 (NCP 2030) provides a comprehensive framework that explicitly connects digitalisation with sustainability objectives. The policy, themed Digitising the Construction Sector, focuses on “accelerating technology adoption in all work processes before, during and after construction”. This comprehensive approach creates natural alignment between digital transformation initiatives and climate response strategies throughout the building life-cycle. By aligning with NCP 2030, JKR can ensure that its digitalisation efforts contribute to broader national objectives for sustainable development and climate resilience.

The policy emphasises several digital technologies with direct relevance to climate adaptation and mitigation. It highlights IoT, AI, augmented reality, 3D printing, and other cutting-edge technologies as “new opportunities to boost the construction industry’s production and efficiency”. These efficiency improvements translate directly to reduced resource consumption and associated environmental impacts, creating environmental co-benefits from productivity enhancements.

NCP 2030 establishes an implementation framework that supports climate-focused digital adoption. The policy recognises that “adopting such innovations and new technology is required for businesses to remain competitive and deliver projects on time and within budget”,

creating economic incentives for environmental improvement. It further emphasises that “this shift must occur swiftly and on a large scale”, acknowledging the urgency of transformation to address pressing climate challenges.

The integration of Industrialised Building System (IBS) with BIM receives particular emphasis as a transformative approach. The policy asserts that “when implemented together, IBS and BIM will effectively transform the construction sector”, creating pathways for simultaneously addressing productivity and sustainability objectives. IBS, Malaysia’s approach to prefabrication and modular construction, demonstrates significant environmental benefits, including reduction of construction waste and reduction of construction-induced carbon emissions.

NCP 2030’s focus on Transforming Construction and Embracing Sustainable Built Environment directly supports JKR’s mission to deliver climate-resilient infrastructure. The policy’s emphasis on technological adoption and innovation creates a conducive environment for integrating digital solutions into public projects.

Contribution to UN SDGs

The integration of digital technologies in JKR’s infrastructure projects directly contributes to multiple SDGs, particularly SDG 9 (Industry, Innovation, and Infrastructure), SDG 11 (Sustainable Cities and Communities), and SDG 13 (Climate Action). By enhancing resource efficiency, reducing waste, and enabling climate-responsive design, digital technologies support sustainable urban development and climate resilience objectives.

SDG 9 benefits from digital technologies that improve construction productivity and innovation, such as BIM and digital twins. These technologies enhance infrastructure quality and resilience, directly contributing to sustainable development objectives. SDG 11 is supported

through improved urban sustainability practices enabled by digital technologies, which facilitate more efficient and environmentally responsible urban development.

SDG 13 receives significant contributions through reduced carbon emissions associated with more efficient construction processes. Digital technologies like digital twins and BIM enable precise energy performance optimisation, enhancing climate adaptability and reducing operational emissions.

Implementation Challenges and Strategies

Despite the potential benefits of digital technologies, their implementation in Malaysia’s construction industry faces several challenges. These include financial constraints, technical complexities, knowledge gaps, and cultural resistance to change. The sector also remains heavily dependent on resource-intensive processes that contribute substantially to carbon emissions, waste generation, and environmental degradation. Traditional construction methods prevalent across much of the industry rely on unskilled manual labour, resulting in inefficiencies that exacerbate environmental impacts. These challenges create urgency for more comprehensive digital adoption specifically targeted toward climate solutions. Addressing these barriers requires comprehensive strategies that include financial incentives, capacity building programmes, and regulatory updates to support innovative practices.

Financial mechanisms should be structured to reward digital implementations that deliver exceptional environmental benefits. Capacity building should integrate digital and sustainability competencies to build implementation capacity. Demonstration projects showcasing successful integration of digital technologies with sustainability practices would provide valuable learning opportunities for the broader industry.

“
Efforts to build digital capacity in the construction workforce should incorporate specific training on environmental applications of these technologies.
”

Implementation Strategies for Climate-Focused Digitalisation

While Malaysia demonstrates promising progress in construction digitalisation, maximising climate benefits requires strategic implementation approaches focused specifically on environmental outcomes. Several key strategies can enhance the climate impact of digital technologies in the construction sector:

- a. **Prioritise Technologies with Substantial Environmental Benefits:** Given limited resources, implementation efforts should prioritise technologies demonstrating exceptional climate benefits. 3D printing represents a prime candidate for focused investment, with documented capabilities to reduce waste by 30-60%. This waste reduction directly addresses a significant environmental challenge in Malaysia's construction sector. Similarly, technologies that enhance building energy performance, such as BIM-integrated energy modelling and IoT-based building management systems, should receive implementation priority based on their climate mitigation potential.
- b. **Develop Climate-Specific Performance Metrics:** To ensure digitalisation efforts translate to meaningful climate outcomes, Malaysia should establish specific environmental performance metrics for digital implementation projects. These metrics should address both direct impacts (such as material waste reduction and operational energy savings) and indirect benefits (such as enhanced climate resilience and adaptation capabilities). Including these metrics in project evaluation frameworks will create accountability for environmental performance while generating valuable data to guide future implementation.
- c. **Enhance Digital Skills Development with Environmental Focus:** Efforts to build digital capacity in the construction workforce should incorporate specific training on environmental applications of these technologies. The MyDIGITAL initiative includes objectives to build the digital capacity of the construction workforce, creating opportunities to integrate climate considerations into skills development programmes. This integration will ensure that the workforce possesses not only technical proficiency but also an understanding of how to apply these technologies for maximum environmental benefit.
- d. **Establish Demonstration Projects Focused on Climate Outcomes:** Showcase projects that demonstrate successful integration of digital technologies with climate objectives will provide valuable

learning opportunities and implementation models. These projects should include comprehensive monitoring and evaluation to document both implementation processes and resulting environmental benefits. Knowledge generated through these projects should be systematically disseminated to accelerate adoption across the industry.

- e. Align Financial Incentives with Climate Performance:** Financial mechanisms should be structured to reward digital implementations that deliver exceptional climate benefits. This approach will help overcome the perception that digital technologies incur high costs and unattractive returns, by creating additional value streams for environmental performance. Tax incentives, preferential financing, and procurement advantages for climate-optimised digital approaches would strengthen economic drivers for technology adoption.

Conclusion

Malaysia's construction industry has demonstrated remarkable progress in digital adoption, positioning the sector for leadership in technology-enabled climate solutions. The explicit policy support provided through the National Construction Policy 2030 and Construction 4.0 Strategic Plan creates a conducive environment for accelerating this transformation. Digitalisation offers a transformative pathway for JKR to enhance the climate resilience of public infrastructure in Malaysia. By leveraging technologies like BIM, digital twins, and IoT, JKR can improve project efficiency, reduce environmental impacts, and enhance the sustainability of its infrastructure projects.

The alignment of these efforts with the JKR Strategic Plan 2021-2025, NCP 2030, and SDGs creates a comprehensive framework for driving digital-sustainability integration in public infrastructure development. By addressing implementation barriers and capitalising on

policy alignments, JKR can position itself as a leader in climate-resilient infrastructure development, contributing to both national development objectives and global sustainability agendas. The resulting built environment would not only reduce environmental impacts but also enhance resilience against climate change effects, protecting infrastructure investments and community well-being in an increasingly uncertain climate future. 🌱

Reference

1. Autodesk & Deloitte (2024). State of Digital Adoption in the Construction Industry 2024. Deloitte Access Economics.
2. Hamzah, L. (2023, September 1). Malaysia's Digital Transformation of the Built Environment in Pursuit of Sustainable Development Goals. <https://www.linkedin.com/pulse/malaysias-digital-transformation-built-environment-pursuit-hamzah/>
3. Kuppasamy, S., Tan N, Y. J., Mari, T., Gunasagaran, S., Tanko, B. L. (2022). Implementation of 3D-printing technology in the Malaysian construction industry. Journal of Engineering Science and Technology Special Issue on STAAUH, 113–129.
4. Anak Sajat, C. J., Baharuddin, H. E. A., & Ghazali, F. (2024). Digitalisation Adoption Toward NCP 2030 in the Malaysian Construction Industry. Built Environment Journal, 21(Special Issue). <https://doi.org/10.24191/bej.v21iSpecial Issue.2446>
5. Ministry of Economy (2024). SDG Roadmap for Malaysia Phase II 2021-2025. [https://ekonomi.gov.my/sites/default/files/2024-09/SDGRoadmapforMalaysia_Phase2\(2021-2025\).pdf](https://ekonomi.gov.my/sites/default/files/2024-09/SDGRoadmapforMalaysia_Phase2(2021-2025).pdf)
6. Ministry of Works (2022). National Construction Policy 2030. <https://www.kkr.gov.my/sites/default/files/2022-10/Dasar-Pembinaan-Negara-NCP2030.pdf>
7. Ministry of Science, Technology and Innovation (2021). National Science, Technology and Innovation Policy 2021-2030. <https://www.mosti.gov.my/wp-content/uploads/2022/03/National-Science-Technology-and-Innovation-Policy-2021-2030.pdf>

Overview of Global E-Governance

by
Mary Foo Mee Sim

In the 21st century, technology has revolutionised every aspect of human life, including governance. E-governance (electronic governance) refers to the use of information and communication technologies (ICTs) to enhance government efficiency, improve public service delivery, and foster citizen engagement. From online tax filing to digital identity systems, e-governance has reshaped how governments interact with citizens and businesses. It plays a crucial role in modern governance by making administrative processes more efficient, transparent, and accessible.

The concept of e-governance emerged alongside the rise of computers and the internet in the late 20th century. The initial phase involved simple digitisation of government records in the 1960s and 1970s. However, the real push for e-governance came in the 1990s with the widespread adoption of the internet.

Governments began using ICT for internal operations (e-administration) in the 1980s to 1990s. By late 1990s, the term e-governance gained prominence with initiatives like the U.S. e-government Act (2002) and the European Union's eEurope strategy. By 2000s, developing countries like India (with the National e-Governance Plan, 2006) and Brazil adopted large-scale e-governance projects.

Today, e-governance leverages Artificial Intelligence (AI), blockchain, cloud computing, and 5G to create smart, responsive governance models. Countries like Estonia, Singapore, and South Korea lead the way with fully digital public administrations.

Applications of E-Governance

E-governance operates across multiple domains, enhancing interactions between governments, citizens, businesses, and employees.

1. Government-to-Citizen (G2C)

- Online portals for public services (tax filing, passport applications, healthcare).
- Digital identity systems (Aadhaar in India, Estonia's e-Residency).
- Grievance redressal platforms.

2. Government-to-Business (G2B)

- Online business registration and licensing.
- E-procurement systems.
- Tax compliance and regulatory filings.

3. Government-to-Government (G2G)

- Inter-departmental data sharing to reduce redundancy.
- Digital record-keeping and document management.
- Smart city initiatives integrating IoT for urban governance.

4. Government-to-Employee (G2E)

- HR management systems for government staff.
- E-learning platforms for training and capacity building.

Benefits of E-Governance

1. Transparency and Accountability
 - Digital records minimise human intervention, reducing bribery and fraud.
 - Public access to government data (open government initiatives).
2. Efficiency and Cost Reduction
 - Automation reduces paperwork and processing time.
 - Lower administrative costs due to digitisation.
3. Improved Service Delivery
 - 24/7 access to government services.
 - Faster response times (e.g., online permits, land records).
4. Citizen Participation
 - Digital platforms for public feedback and policy discussions.
 - Social media engagement for governance.
5. Economic Growth
 - Ease of doing business improves with digital compliance.
 - Digital financial inclusion (e.g., direct benefit transfers).

Challenges in E-Governance Implementation

Despite its advantages, e-governance faces several challenges in its implementation such as:

- Digital divide with unequal internet access in rural vs. urban areas and low digital literacy among older populations.
- Cybersecurity risks with data breaches and hacking threats and privacy concerns with centralised databases.
- Infrastructure limitations with poor internet connectivity due to high-speed internet and cloud infrastructure in developing nations and high cost of technology adoption.
- Resistance to change with bureaucratic reluctance to adopt digital workflows and lack of political will in some regions.

Current Global Trend and Status of E-Governance

The global trend in e-governance is embracing the following technologies:

- AI and Big Data: Predictive governance and automated decision-making.
- Blockchain: Secure voting and land registry systems.
- 5G and IoT: Smart city integrations for real-time governance.

The leading countries in e-governance includes Estonia with its pioneered e-residency and digital governance, Singapore with its “Smart Nation” initiative with AI-driven services, Korea with its high citizen engagement in digital governance and India with its Aadhaar, DigiLocker, and UMANG app for unified services.

The Way Forward for E-Governance

With the accelerating 4IR innovation, e-governance is projected to embark on

- Hyper-personalisation: AI-driven customised citizen services such as Chatbots,
- Decentralised Governance: Blockchain for tamper-proof records and
- Global collaboration: Cross-border e-governance initiatives (e.g., EU digital identity).

Conclusion

E-governance has transformed traditional bureaucracy into a dynamic, citizen-centric model. While challenges like the digital divide and cybersecurity persist, advancements in AI, blockchain, and IoT promise a future where governments operate with unprecedented efficiency and transparency.

Countries leading in e-governance today are setting benchmarks for others, proving that digital governance is no longer optional and that it is essential for inclusive, sustainable development. As technology evolves, the next decade will see even more innovative, responsive, and participatory governance models worldwide. 🌐

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Page Size - 210mm x 280mm
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Role of Engineers in Concept of Cultural Mapping

by
Samniang Saenram

In an era of accelerating urbanisation and globalisation, the integration of cultural heritage and identity into the built environment is gaining renewed importance. Cultural mapping, an evolving approach to documenting, visualising, and managing cultural assets, has emerged as a key tool in this process. Traditionally associated with the fields of arts and heritage conservation, cultural mapping is now recognised as a valuable instrument for planners, architects, engineers, and policy-makers working toward sustainable and inclusive development.

Engineers, in particular, have an increasingly significant role to play, working collaboratively with other professions to ensure that cultural insights are effectively translated into resilient, functional, and context-sensitive urban infrastructure. This article examines the concept of cultural mapping, the role of engineers and their interaction with other professions, Malaysia's position, and the evolving global trends in this field.

The Concept

Cultural mapping refers to the process of systematically identifying, documenting, and representing a community's cultural resources, both tangible and intangible. Tangible assets include heritage buildings, monuments, cultural landscapes, and traditional crafts. Intangible assets cover oral histories, rituals, languages, local knowledge, performing arts, and social practices.

The purpose of cultural mapping extends beyond simple documentation. It serves as a strategic tool for community engagement, heritage conservation, place-making, and inclusive urban planning. By visualising the cultural fabric of a community, cultural mapping informs decisions on land use, urban design, infrastructure development, and tourism. More importantly, it fosters a sense of identity and belonging among local populations while promoting intercultural dialogue and understanding.

Interaction with Other Professions

While cultural mapping is often led by social scientists, cultural practitioners, and planners, engineers have an essential and growing role in its application to the built environment. Their contributions extend across several dimensions:

1. Technical Integration of Cultural Assets.

Engineers provide the technical expertise required to conserve and adapt heritage structures. For example, retrofitting old buildings for structural stability, seismic resilience, or modern utilities must be done sensitively to preserve cultural value. Engineers ensure that such interventions respect architectural authenticity while meeting safety and performance standards.

2. Sustainable Infrastructure Design.

Engineers contribute to designing infrastructure that complements cultural

landscapes. For example, in designing bridges, roads, and public utilities, engineers must collaborate with planners and architects to avoid disrupting heritage sites and to incorporate aesthetic and symbolic elements derived from cultural mapping.

For example in Kyoto, Japan, infrastructure development often incorporates rigorous cultural mapping to protect traditional Machiya houses and centuries-old temples. When engineers install underground utilities or reinforce buildings against earthquakes, they use non-invasive methods such as micro-tunnelling or retrofitting techniques that preserve the original facades. These practices are guided by local policies that integrate engineering standards with cultural heritage guidelines, showing a long-standing tradition of harmony between development and heritage conservation.

In Malaysia, during the construction of the Kelana Jaya Light Rail Transit (LRT) line in Kuala Lumpur, engineers had to carefully design the underground portion of the track near Masjid Jamek, one of the oldest mosques in Malaysia, circa 1909. To protect the structural integrity of this heritage mosque, engineers undertook geotechnical investigations and used advanced tunnelling methods such as Tunnel Boring Machines (TBMs) to avoid disturbing the building foundation. The construction sequence was meticulously planned to minimise vibrations and settlement impacts. In this case, engineering not only enabled modern transportation development but also safeguarded a piece of local Islamic and colonial architectural heritage.

Material Innovation & Local Techniques

Engineers can help revive and adapt traditional construction materials and techniques. Insights from cultural mapping often reveal indigenous knowledge and craftsmanship that can inspire modern, sustainable building practices such as

the use of natural ventilation, passive cooling, and vernacular architecture.

Collaboration with Other Professions

The integration of cultural mapping into development requires a multidisciplinary approach. Engineers interact with:

- Architects, to translate cultural narratives into spatial and structural design.
- Planners, to embed cultural priorities into zoning, land use, and urban form.
- Sociologists and Anthropologists, to understand the social and cultural significance of sites and practices.
- Community Groups, whose knowledge and perspectives shape the cultural mapping process and guide design priorities.

Through close collaboration, engineers help bridge the gap between cultural sensitivity and technical feasibility.

Position of Malaysia

Malaysia, with its rich multicultural heritage, is well-positioned to leverage cultural mapping in urban development and heritage conservation. Historic cities such as Georgetown and Melaka have UNESCO World Heritage status, and cultural mapping efforts there have supported heritage tourism and urban regeneration.

The National Heritage Department has initiated various programmes to document cultural resources. Moreover, the Low Carbon Cities Framework and Smart City Initiatives are increasingly recognising the importance of cultural and social sustainability alongside environmental and economic goals.

However, challenges remain. Cultural mapping is not yet systematically integrated into engineering practice or mainstream urban planning in many Malaysian cities. Coordination across federal, state, and local levels is uneven, and public participation in cultural mapping

“ Cultural mapping is increasingly linked to resilience planning. ”

and heritage decision-making needs to be strengthened. There is also a need for better cross-disciplinary education and training for engineers and other built environment professionals.

On the positive side, younger engineers in Malaysia are increasingly aware of cultural sustainability issues, especially those working on conservation, adaptive reuse, and community-based infrastructure projects.

Global Trends

Globally, cultural mapping is evolving as a dynamic and participatory process. Several trends are shaping its future.

1. Digital Cultural Mapping.

Advances in Geographic Information Systems (GIS), digital twins, augmented reality, and crowdsourced mapping are enabling more interactive and accessible cultural mapping. Engineers and data scientists play a critical role in building these platforms.

2. Resilience & Climate Adaptation.

Cultural mapping is increasingly linked to resilience planning. Identifying culturally significant places and practices can inform strategies for climate adaptation and disaster risk reduction. Engineers design infrastructure that protects both human life and cultural heritage.

3. Inclusive Place-Making.

There is a growing emphasis on inclusive cultural mapping, engaging indigenous communities, minority groups, and marginalised voices. Engineers must work alongside social scientists to ensure that technical solutions respect cultural sensitivities and promote social equity.

4. Interdisciplinary Collaboration.

The trend toward collaborative design (combining engineering, architecture, planning, and cultural expertise) is gaining momentum. Professional bodies and educational institutions worldwide are promoting interdisciplinary curricula and project-based learning that reflect this approach.

Conclusion

Cultural mapping offers a powerful framework for preserving heritage, fostering identity, and promoting inclusive, sustainable development. Engineers, through their ability to translate cultural insights into physical infrastructure and technical solutions, play a vital role in this process. Their collaboration with architects, planners, and cultural practitioners ensures that the built environment reflects and enhances the cultural fabric of society.

In Malaysia, significant progress has been made, particularly in heritage cities, but greater institutional integration of cultural mapping into engineering and planning practice is needed. Globally, the convergence of digital technology, sustainability imperatives, and inclusive design is driving new forms of cultural mapping and collaboration.

As engineers embrace a more holistic view of their role, not only as builders of infrastructure but as stewards of cultural and social values, they will be key contributors to the creation of cities that honour the past while innovating for the future. 🏡

Cybersecurity Protocols for Critical Engineering Systems

by
Ong Em Nee

In an era of rapid digitalisation, critical engineering systems such as power plants, oil & gas pipelines, and transportation networks are increasingly interconnected and reliant on complex cyber-physical infrastructures. While this transformation is efficient and flexible, it also exposes these vital systems to a growing array of cyber threats.

The potential consequences of cyberattacks, ranging from large-scale blackouts to disruptions of supply chains and public services, have led governments and industries worldwide to prioritise the development of robust cybersecurity protocols. Recent global conventions and initiatives reflect a shared recognition of the need for collaborative action to safeguard these systems.

Rising Threat Landscape

Historically, critical infrastructure was largely isolated from external networks. However, the integration of Industrial Control Systems (ICS), Supervisory Control and Data Acquisition (SCADA) systems, and the Industrial Internet of Things (IIoT), has made these systems more vulnerable to cyber intrusions. High-profile incidents such as the Stuxnet attack on Iranian nuclear facilities (2010), the cyberattacks on Ukraine's power grid (2015 and 2016), and the Colonial Pipeline ransomware attack in the United States (2021) have highlighted the real-world risks of cyberattacks on critical engineering systems.

These events have underscored the importance of international cooperation and the

development of comprehensive cybersecurity protocols to prevent, detect, and mitigate such attacks.

International Conventions & Collaborative Efforts

1. United Nations Initiatives

The United Nations (UN) has played a pivotal role in promoting global cybersecurity norms. Both the UN Group of Governmental Experts (GGE) and the Open-ended Working Group (OEWG) on developments in the field of information and telecommunications in the context of international security have emphasised the importance of protecting critical infrastructure.

Recent UN discussions have encouraged member states to adopt voluntary norms and confidence-building measures, to promote capacity building, and to foster greater information sharing regarding threats to critical systems.

2. European Union's NIS2 Directive

The European Union (EU) updated its Network & Information Security (NIS) Directive with NIS2 in 2023, to address the evolving threat landscape. NIS2 has a wider scope covering a broader range of critical sectors, including energy, transport, health, and digital infrastructure. Key provisions of NIS2 include:

- Strengthened risk management requirements for operators of essential services.
- Mandatory incident reporting within 24 hours of detection.

- Enhanced oversight by national cybersecurity authorities.
- Greater cross-border cooperation among EU member states.

The aim is to harmonise cybersecurity practices across the EU and to improve resilience against both known and emerging threats.

3. US Cybersecurity Initiatives

In the United States, the Executive Order 14028, issued in 2021, catalysed significant advancements in cybersecurity practices for critical infrastructure. This order mandates:

- Zero Trust Architecture adoption.
- Improved supply chain security.
- Enhanced sharing of threat intelligence between government and private sector entities.

Additionally, the Cybersecurity & Infrastructure Security Agency (CISA) launched the Shields Up initiative in 2022, providing continuous updates and guidance to critical infrastructure operators in response to evolving global threats.

4. Asia-Pacific Cooperation

The Asia-Pacific region, home to many rapidly developing economies and critical global supply chains, has also advanced cybersecurity through regional forums such as the Asia-Pacific Economic Cooperation (APEC). The APEC Telecommunications & Information Working Group promotes cybersecurity awareness and resilience, with specific focus areas including the energy and transportation sectors.

Japan, South Korea, and Singapore have established national centres of excellence in industrial cybersecurity, while China has implemented the Cybersecurity Law of 2017, which sets strict security requirements for operators of critical information infrastructure.

5. International Standards & Best Practices

Beyond national and regional conventions, international standards organisations have provided frameworks for enhancing cybersecurity. The International Electrotechnical

Commission (IEC) standard IEC 62443 outlines comprehensive security requirements for industrial automation and control systems, while the International Organisation for Standardisation (ISO) offers ISO/IEC 27001 for broader information security management.

These standards help establish consistent protocols across industries and geographies, facilitating better protection for globally interconnected engineering systems.

Key Elements of Effective Cybersecurity Protocols

Across these conventions and initiatives, several core principles have emerged as best practices:

- Defence in-depth strategies that layer security controls.
- Zero Trust Architecture, requiring continuous verification of all users and devices.
- Real-time monitoring and anomaly detection to identify cyber threats promptly.
- Incident response planning to ensure rapid recovery from cyberattacks.
- Supply chain security to mitigate risks from third-party vendors and components.
- Continuous workforce training and awareness to address the human element of cybersecurity.

Conclusion

As the digital transformation of critical engineering systems accelerates, so too does the urgency to protect them from cyber threats.

Recent global conventions and collaborative efforts mark a significant step forward in aligning international priorities and practices. However, the dynamic nature of cyber threats demands constant vigilance, innovation, and cooperation.

A multi-stakeholder approach encompassing governments, industries, academia, and civil society, will be essential to building and maintaining resilient critical infrastructure in the face of an increasingly complex cyber threat landscape. 🌐

Rise of Smart Construction: IoT & AI at the Jobsite

by
Cheo Hong Keyong

The construction industry, long known for its reliance on manual labour and traditional methods, is undergoing a digital revolution. Fueled by advancements in the Internet of Things (IoT) and Artificial Intelligence (AI), smart construction is transforming how projects are designed, monitored, and executed. These technologies are helping companies improve productivity, enhance safety, and make more informed decisions.

In this article, we explore how IoT and AI are reshaping modern construction sites, examining their applications, benefits, challenges, and future prospects.

Understanding Smart Construction

Smart construction refers to the integration of digital technologies, particularly IoT and AI, into construction processes to improve operational efficiency, quality, and safety. By embedding sensors, data analytics, and intelligent systems into various construction activities, project teams can monitor conditions in real time, predict outcomes, and automate decision-making.

IoT Connecting the Jobsite

IoT is a network of interconnected devices embedded with sensors, software, and connectivity which enables it to collect and exchange data. In construction, IoT devices provide real-time visibility into equipment

usage, worker movement, material inventory, and environmental conditions. Applications include:

1. Equipment and Asset Tracking

Construction equipment is often expensive and scattered across multiple sites. IoT-based GPS trackers and RFID tags allow managers to monitor the location and utilisation of machinery and tools, reducing loss and downtime.

2. Predictive Maintenance

Sensors attached to heavy machinery can collect data on vibration, temperature, and usage hours. This enables predictive maintenance, allowing equipment to be serviced before failure, minimising breakdowns and costly delays.

3. Environmental Monitoring

IoT sensors can track site conditions such as temperature, humidity, noise, and dust levels. This helps ensure compliance with safety regulations and improves worker health by reducing exposure to hazardous environments.

4. Structural Health Monitoring

Smart sensors embedded in structures like bridges, tunnels, and buildings can detect early signs of strain, deformation, or corrosion, ensuring long-term structural integrity and enabling timely intervention.

The Power of Intelligence

AI involves the simulation of human intelligence in machines for learning and problem-solving. In construction, AI systems analyse vast amounts of data generated from job sites to optimise planning, execution, and resource allocation.

1. Construction Planning and Design

AI algorithms can analyse architectural drawings, historical data, and site conditions to generate optimised construction schedules. Tools like generative design explore multiple design alternatives based on constraints and recommend the most efficient layout.

2. Project Risk Prediction

By analysing past project data, AI systems can identify potential risks such as cost overruns, schedule delays, and safety hazards. This allows managers to take preemptive actions and allocate resources more effectively.

3. Safety Enhancement

AI-powered computer vision systems can monitor video feeds from job sites to detect unsafe behaviour, such as workers without helmets or entering restricted zones. Alerts can be sent in real time to prevent accidents.

4. Robotics and Automation

AI-driven robots are being used for repetitive and high-risk tasks like bricklaying, welding, and rebar tying. These machines increase productivity and reduce human exposure to hazardous conditions.

Case Studies & Industry Applications

1. Komatsu: Smart Construction Initiative

Komatsu, a Japanese heavy equipment manufacturer, has developed an IoT-based Smart

Construction platform that integrates drones, GPS-equipped machinery, and AI to automate site surveying, earthmoving, and grading.

2. Boston Dynamics: Spot Robot

Spot, a robotic dog developed by Boston Dynamics, is being deployed on construction sites to capture site progress using 3600 cameras and thermal sensors. The data is used for comparison with BIM models to track project status.

3. Dubai: 3D-Printed Office

Dubai has constructed the world's first fully functional 3D-printed office building using AI-driven design algorithms and robotic arms. The project demonstrated how smart technologies could reduce construction time and material waste.

Benefits of Smart Construction

1. Increased Productivity

Automation and data-driven decision-making reduce inefficiencies and idle time, enabling faster project completion with fewer resources.

2. Enhanced Safety

Real-time monitoring and AI-based alerts improve worker safety and reduce the risk of injuries and fatalities.

3. Better Quality Control

Sensors and AI can detect anomalies or deviations from plans early in the process, ensuring higher construction quality.

4. Sustainability and Resource Efficiency

Smart systems can optimise material usage, reduce waste, and improve energy efficiency, critical for meeting sustainability goals and ESG commitments.

5. Cost Savings

By preventing equipment failures, reducing rework, and optimising resource allocation, smart technologies can significantly lower overall project costs.

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Construction personnel
need training to adapt
to digital tools and
interpret data insights.
”

Challenges & Barriers

Despite the potential, smart construction faces several challenges:

1. High Initial Investment

Implementing IoT and AI technologies requires substantial capital, which may be a barrier for small and medium-sized firms.

2. Data Security and Privacy

The increased use of connected devices raises concerns about data breaches and cybersecurity, especially when handling sensitive project or employee information.

3. Skill Gaps

Construction personnel need training to adapt to digital tools and interpret data insights. The industry faces a shortage of professionals with cross-disciplinary expertise in engineering and data science.

4. Integration and Interoperability

Different devices and software platforms may lack standardised protocols, leading to compatibility issues and fragmented data systems.

The Future

The evolution of smart construction is just beginning. With the rise of 5G networks, edge computing, and AI advancements, the capabilities of connected jobsites will continue to expand. Future innovations may include:

- Autonomous construction vehicles for excavation, hauling, and material handling.
- AI-generated digital twins of construction sites for virtual walkthroughs and planning.
- Blockchain for secure and transparent project contracts and supply chain management.
- Augmented Reality (AR) systems for real-time visual overlays during assembly and inspection.

Conclusion

Smart construction powered by IoT and AI is fundamentally altering the landscape of the building industry. These technologies enable engineers and contractors to build faster, safer, and smarter than ever before.

While challenges remain in terms of investment, skills, and system integration, the long-term benefits far outweigh the hurdles. As more stakeholders embrace these innovations, smart construction is poised to become the new standard and redefining what is possible on the modern jobsite. 🏗️

Reference

1. McKinsey & Company. (2017). Reinventing construction through a productivity revolution.
2. Deloitte Insights. (2020). The future of work in construction: How AI, robotics, and automation are transforming the industry.
3. World Economic Forum. (2016). Shaping the Future of Construction: A Breakthrough in Mindset and Technology.
4. Construction Industry Institute (CII). (2018). Smart Construction: Leveraging the Interplay of Digital Technologies.
5. Komatsu Ltd. (2022). Smart Construction Solutions.
6. Harvard Business Review. (2018). The Internet of Things Comes to the Construction Site.

Transformation of the Solar Panel Industry: Innovations, Markets, and Global Leadership

by
Chin Fong Yin

The solar panel industry has undergone a transformative journey over the past several decades. Once a niche technology with limited application and prohibitively high costs, solar photovoltaic (PV) panels have emerged as a central pillar of the global transition to sustainable energy. This transformation has been propelled by technological innovation, economies of scale, supportive policy frameworks, and fierce international competition.

As the world grapples with climate change and energy security, solar energy has become not only a viable solution but also a symbol of economic progress and environmental stewardship. This article explores the background of the solar industry, the breakthroughs that have fuelled its growth, the economic dynamics that shaped its competitiveness, and the countries that lead this renewable revolution.

Historical Background & Early Developments

The conceptual foundation of solar power traces back to the 19th century. In 1839, French physicist Alexandre Edmond Becquerel discovered the photovoltaic effect, laying the groundwork for solar technology. But it wasn't until 1954 that Bell Labs developed the first practical silicon solar cell, which converted sunlight to electricity with about 6% efficiency. Initially, solar panels were used in specialised

applications such as satellites and remote telecommunications.

Throughout the 1970s and 1980s, interest in solar energy grew in response to oil shocks and environmental concerns. However, the technology remained expensive and inefficient for widespread use. The lack of industrial scale and high production costs limited the adoption of off-grid applications and niche markets.

Technological Innovations & Breakthroughs

In the past two decades, solar PV technology advanced at a rapid pace, driven by material science innovations, manufacturing improvements, and research investments. The dominant technology remains crystalline silicon (c-Si) solar cells, which have seen continuous improvements in efficiency and production techniques.

Key innovations include:

- **PERC (Passivated Emitter & Rear Contact) Cells:** This enhancement to traditional solar cells significantly improves light capture and efficiency, pushing average module efficiencies above 21%.
- **Bifacial Modules:** These panels capture sunlight from both the front and rear sides, increasing total energy output by up to 20%.
- **Heterojunction Technology (HJT):**

Combining amorphous and crystalline silicon layers, HJT achieves high efficiency and lower degradation over time.

- **Thin-Film Technologies:** Materials such as cadmium telluride (CdTe) and copper indium gallium selenide (CIGS) enable lightweight, flexible panels for niche applications, although the market share is smaller compared to silicon-based modules.
- **Perovskite Solar Cells:** Emerging as a game-changer, perovskite offer potential for high efficiency and low-cost production. Though stability and scaling challenges remain, hybrid perovskite-silicon tandems have already achieved lab efficiencies exceeding 30%.
- **Floating Solar & Agrivoltaics:** Innovative deployment models such as floating solar farms and co-located agricultural-solar installations have expanded the applicability of solar energy, optimising land use and water conservation.

Economic Dynamics & Scale Economies

One of the most dramatic aspects of the solar industry transformation has been the precipitous decline in costs. Since 2010, the cost of utility-scale solar PV dropped by more than 80%, according to the International Renewable Energy Agency (IRENA). This reduction stems from:

- **Economies of Scale:** As production volumes increased, manufacturers achieved lower costs per unit due to mass production, improved supply chains, and standardised processes.
- **Learning Curve Effects:** Each doubling of installed solar capacity historically reduced costs by about 20%, a phenomenon known as Swanson's Law.
- **Vertical Integration and Automation:** Leading companies integrated vertically to streamline operations and reduce reliance on third-party suppliers.

Automation and precision engineering further cut labour and production costs.

- **Falling Balance of System (BoS) Costs:** In addition to panel costs, inverters, mounting hardware, and installation costs also declined, contributing to overall affordability.

The result is that solar power has become the cheapest source of new electricity in many regions, outcompeting fossil fuels and even other renewables such as wind in certain markets.

Global Market Landscape

The global solar PV market has grown exponentially, with total installed capacity surpassing 1 terawatt (TW) in 2023. Growth has been led by utility-scale projects, though residential and commercial installations also contribute significantly. The market is broadly categorised into three segments: Utility-scale, commercial/industrial, and residential.

- **Utility-Scale Solar:** Driven by competitive auctions and power purchase agreements (PPAs), large-scale solar farms dominate new installations in countries with ample land and sunlight.
- **Commercial and Industrial (C&I):** Businesses are increasingly adopting solar to reduce operational costs and to meet sustainability goals, especially in regions with high electricity tariffs.
- **Residential Solar:** Growth in this segment is supported by net metering policies, subsidies, and consumer interest in energy independence. Integration with battery storage and smart home systems further enhances appeal.

Global market leaders include:

- **China.** The undisputed leader in both manufacturing and deployment, China accounts for more than 50% of global solar installations and over 80% of the world's solar manufacturing capacity.

“

In addition, multilateral climate agreements such as the Paris Agreement have reinforced global commitments to renewable energy, further driving solar investment.

”

Companies such as LONGi, Trina Solar, JA Solar, and JinkoSolar dominate the module market.

- **USA.** With significant utility-scale and residential adoption, the USA is a major market, though its manufacturing capacity lags behind. Federal incentives such as the Inflation Reduction Act are boosting domestic production and deployment.
- **India.** Rapidly scaling its renewable energy capacity, India ranks among the top solar markets. The government's ambitious targets and push for local manufacturing under the Make in India initiative, are shaping the sector's future.
- **Europe.** Germany, Spain, and the Netherlands are leaders in deployment, driven by feed-in tariffs and climate goals. The EU is also seeking to reshore manufacturing as part of its energy sovereignty strategy.
- **Emerging Markets.** Nations in Africa, South-East Asia, and Latin America are embracing solar to meet rising energy demands, to reduce dependence on imported fuels, and to electrify rural areas.

Policy & Regulatory Support

Government policies play a crucial role in shaping the solar industry. Early subsidies, feed-in tariffs, tax incentives, and renewable portfolio standards created demand and incentivised private investment. More recently, market-based mechanisms such as reverse auctions and green finance have taken precedence.

Examples of impactful policies include:

- **Germany's EEG (Renewable Energy Sources Act):** Sparked the initial solar boom in the 2000s through generous feed-in tariffs.
- **China's Top Runner Programme:** Encouraged technological advancement and consolidation in the solar industry.
- **USA Investment Tax Credit (ITC):** Significantly boosted residential and commercial solar adoption.
- **Net Metering:** Widespread in many countries, net metering allows consumers to sell excess solar electricity back to the grid, improving return on investment.

In addition, multilateral climate agreements such as the Paris Agreement have reinforced global commitments to renewable energy, further driving solar investment.

Challenges & Sustainability Concerns

Despite its many advantages, the solar industry faces several challenges:

- **Supply Chain Risks.** Geopolitical tensions, trade tariffs, and overreliance on Chinese manufacturing raise concerns about supply chain security.
- **Resource and Environmental Impacts.** Mining of rare earth elements, use of toxic chemicals in thin-film modules, and end-of-life panel disposal need to be addressed to ensure long-term sustainability.
- **Grid Integration.** High solar penetration can create issues with intermittency, overgeneration, and grid stability, necessitating advancements in energy storage, demand response, and smart grid technologies.
- **Workforce & Skills Development.** As the industry grows, training programmes are needed to equip workers with skills in installation, maintenance, and systems management.

Future Outlook

Looking ahead, the solar panel industry is poised for continued growth and innovation. Projections suggest that global solar capacity can exceed 5 TW by 2030, driven by:

- **Next-Generation Technologies.** Perovskites, tandem cells, quantum dots, and printable solar materials hold promise for efficiency breakthroughs and new applications.
- **Energy Storage Integration.** Coupling solar with batteries will enhance reliability and enable grid independence.
- **Decentralised Energy Systems.** Peer-to-peer energy trading, community solar, and virtual power plants are redefining energy distribution models.
- **Green Hydrogen.** Solar-powered electrolysis to produce green hydrogen

may open new industrial decarbonisation pathways.

- **Circular Economy Models:** Panel recycling, reuse, and extended producer responsibility will become increasingly important for minimising environmental impact.

Conclusion

The solar panel industry stands at the forefront of the global energy transition. From its humble beginnings as a scientific curiosity, solar PV has become a mature, competitive, and indispensable technology. Its transformation is a testament to human ingenuity, international cooperation, and the power of market forces aligned with environmental imperatives.

As nations race to meet net-zero targets and to secure their energy futures, solar energy is not just a clean alternative; it is a strategic asset. With ongoing innovations, supportive policies, and global collaboration, the sun may very well power the next era of economic and environmental progress. 🌞

Reference

1. International Renewable Energy Agency (IRENA) - Renewable Power Generation Costs, World Energy Transitions Outlook.
2. International Energy Agency (IEA) - World Energy Outlook, Global Solar PV Market Report, and Trends in Photovoltaic Applications.
3. National Renewable Energy Laboratory (NREL), U.S. Department of Energy - Research on PERC, bifacial, and perovskite solar cells.
4. World Bank and International Finance Corporation (IFC) - Reports on solar adoption in developing countries, off-grid solar, and investment trends.

Global Supply Chain in Trade and Investment: Engineering Works and the ASEAN-Malaysia Nexus

by
Cheo Hong Keyong

Global supply chains have transformed the way the world trades, produces, and invests. The modern supply chain is not a linear path but a complex, interconnected network that spans continents, industries, and technologies. Fueled by globalisation, digitisation, and evolving consumer demands, supply chains have grown into intricate systems requiring advanced engineering, logistical planning, and international collaboration. Today, supply chains are not just conduits for products but are strategic assets in economic development and global competitiveness.

The Association of South-East Asian Nations (ASEAN), particularly Malaysia, has emerged as a critical node in the global supply chain ecosystem. Positioned strategically between the Indian and Pacific Oceans, ASEAN countries have become popular destinations for trade and investment due to competitive labour markets, expanding infrastructure, and proximity to major markets such as China, Japan, and India. Within this regional landscape, Malaysia stands out for its robust industrial base, well-developed infrastructure, and strategic economic policies. This article explores the current global supply

chain situation in trade and investment, the engineering works that support it, and the roles of ASEAN and Malaysia in this evolving landscape.

Global Supply Chain Dynamics

Global supply chains have evolved over decades, driven by factors such as trade liberalisation, technological innovation, and capital mobility. Companies increasingly fragmented their production processes, sourcing raw materials from one country, manufacturing in another, and assembling in yet another before reaching end consumers. This global distribution of tasks is referred to as global value chains (GVCs).

However, this model has faced significant challenges in recent years:

- **Pandemic-Driven Disruptions.** COVID-19 highlighted vulnerabilities in global supply chains, from semiconductor shortages to delays in medical equipment. The just-in-time model, once lauded for efficiency, revealed a lack of resilience.
- **Geopolitical Tensions.** The US-China trade war and Brexit have prompted businesses to diversify sourcing and to reconsider offshoring strategies.

“Supply chains are underpinned by extensive engineering systems that enable the efficient flow of goods, data, and capital.”

- **Environmental and ESG Concerns.** Increasing scrutiny on environmental, social, and governance (ESG) practices has pushed firms to adopt sustainable sourcing and production methods.
- **Technological Shifts.** The 4th Industrial Revolution (4IR) has introduced AI, blockchain, IoT, and robotics into supply chain management, reshaping operations and logistics.
- **Industrial & Systems Engineering.** Engineers optimise production lines, warehouse management, and distribution networks through process engineering, operations research, and data analytics.
- **Software & Data Engineering.** Modern supply chains are increasingly digital. Blockchain ensures traceability, AI enables predictive logistics, and cloud platforms support real-time inventory management.
- **Environmental Engineering.** With a growing focus on sustainability, engineers are designing green warehouses, eco-friendly packaging, and renewable energy solutions to minimise the environmental footprint of supply chains.

Engineering Works Enabling Global Supply Chains

Supply chains are underpinned by extensive engineering systems that enable the efficient flow of goods, data, and capital. These include:

- **Civil & Structural Engineering.** Construction of ports, airports, railroads, highways, and logistics hubs is essential for efficient cargo movement. Iconic projects such as the expansion of the Suez and Panama Canals, or China's Belt & Road Initiative, illustrate how civil engineering shapes global trade routes.
- **Mechanical & Electrical Engineering.** These disciplines are crucial in building and maintaining machinery, automation systems, transportation equipment, and energy infrastructure that drive manufacturing and logistics.

ASEAN: A Rising Force in Global Supply Chains

ASEAN has positioned itself as a strategic manufacturing and logistics hub, offering a cost-effective and diversified alternative to China. The bloc's young workforce, improving infrastructure, and trade agreements make it an attractive destination for multinational corporations.

Key initiatives that have strengthened the role of ASEAN include:

- ASEAN Free Trade Area (AFTA) and the Regional Comprehensive Economic Partnership (RCEP), which facilitate easier trade flows.
- Master Plan on ASEAN Connectivity (MPAC) 2025, aiming to integrate transportation, digital, and energy infrastructure across member states.
- ASEAN Smart Logistics Network (ASLN), promoting smart, resilient, and sustainable logistics systems.

Engineering Projects Driving ASEAN Supply Chain Integration

- Connectivity Infrastructure:
 1. Laos-China Railway linking Vientiane and Kunming.
 2. Thailand's Eastern Economic Corridor (EEC) with high-speed rail and deep-sea ports.
 3. Singapore's Tuas Mega Port, one of the world's most advanced automated ports.
- Digital Supply Chains:
 1. IoT-enabled smart warehouses in Vietnam and Thailand.
 2. Cloud-based ERP systems enabling real-time inventory tracking across ASEAN.
- Green Engineering Projects:
 1. Renewable energy projects in Indonesia and the Philippines to power logistics parks.
 2. Circular economy initiatives in Thailand focusing on sustainable packaging.

Malaysia's Role in the ASEAN Supply Chain Landscape

Malaysia has consistently ranked among the top global manufacturing and export economies, with strong capabilities in electronics, automotive, chemicals, and palm oil industries.

Its geographic position in the heart of ASEAN makes it a gateway for regional and global trade.

Key strengths of Malaysia:

- World-class infrastructure, including five international airports, seven major seaports, and the North-South Expressway.
- Advanced industrial parks such as the Kulim Hi-Tech Park and Penang Science Park.
- Investment-friendly policies under institutions such as the Malaysian Investment Development Authority (MIDA).
- Integration with global trade agreements, including CPTPP and RCEP.

Major engineering works in Malaysia supporting supply chains:

• Port & Airport Development

1. Port Klang and Port of Tanjung Pelepas are among the busiest in South-East Asia.
2. Expansion of Kuala Lumpur International Airport (KLIA) to support cargo and passenger logistics.

• Rail & Road Projects

1. The East Coast Rail Link (ECRL) will connect key industrial regions and ports.
2. Ongoing expansion of the Pan Borneo Highway, enhancing connectivity with East Malaysia.

• Digital Engineering

1. Malaysia Digital Economy Blueprint (MyDIGITAL) aims to enhance digital infrastructure and logistics tech.
2. Adoption of 5G and smart sensors in logistics hubs and warehouses.

• Green Engineering & Sustainability

1. Solar energy initiatives in Selangor and Perak powering industrial zones.
2. Green Building Index (GBI)-certified warehouses and industrial facilities.

“Engineering lies at the heart of this transformation, enabling the construction and operation of complex logistics networks.”

Malaysia a Hub for High-Tech Supply Chains

Malaysia is moving up the value chain by focusing on high-tech and knowledge-intensive industries. Penang, dubbed the Silicon Valley of the East, is home to electronics giants such as Intel, AMD, and Bosch. This transition requires advanced engineering in:

- Semiconductor design and fabrication.
- Precision tooling and robotics.
- Cleanroom infrastructure for electronics manufacturing.

In addition, its engineering talent pool is being nurtured through Technical and Vocational Education and Training (TVET) and partnerships between universities and industry.

However, despite progress, Malaysia and ASEAN face several challenges:

- Infrastructure gaps in rural and secondary cities.
- Bureaucratic inefficiencies in cross-border trade and customs.
- Skilled labour shortages in fields such as automation and data analytics.
- Climate risks, including floods and rising sea levels, affect infrastructure resilience.

To overcome these, continued investment in engineering innovation, public-private partnerships, and regional cooperation

are essential. Malaysia can further strengthen its position by:

- Enhancing integration with ASEAN logistics networks.
- Incentivising green engineering practices.
- Building smart ports and smart cities using AI and IoT.

Conclusion

The global supply chain is undergoing a transformation shaped by resilience, sustainability, and digitalisation. Engineering lies at the heart of this transformation, enabling the construction and operation of complex logistics networks. ASEAN, with Malaysia as a central player, is uniquely positioned to capitalise on these changes. Through strategic infrastructure development, technological adoption, and sustainable practices, Malaysia is poised to be a regional hub in the future of global trade and investment.

To remain competitive, we must continue investing in engineering excellence and innovation. The synergy between trade policy, investment frameworks, and engineering infrastructure will define how effectively the nation and region navigate the challenges and opportunities of the 21st century supply chain ecosystem. 🌐

Introduction to Sports Engineering: Engineering the Game

by
Mary Foo Mee Sim

Sports is a universal language, one that transcends cultures, unites communities, and challenges the limits of human ability. Behind every world record performance, state-of-the-art stadium, or revolutionary sportswear lies an intricate web of science and engineering. Sports engineering is the emerging discipline at this intersection, where innovation meets athleticism.

Defined as the application of engineering principles to solve problems in sport, sports engineering combines mechanics, materials science, electronics, biomechanics, data analytics, and ergonomics to improve performance, safety, and experience. As engineering disciplines evolve and diversify, sports engineering presents a compelling frontier that offers both societal impact and technical challenges, making it an attractive field for engineers from all disciplines.

- Electrical and electronics engineering support sensor systems and wearable tech.
- Materials engineering innovates with lighter and stronger composites.
- Biomedical and biomechanical engineering help understand body movement.
- Civil engineering designs world-class arenas.
- Software and data engineers, meanwhile, provide critical insights through analytics, simulation, and artificial intelligence.

The global sports industry, valued at over US\$500 billion in 2023, is projected to reach US\$700 billion by 2030. A significant portion of this growth is driven by technology and engineering innovations in equipment, facilities, and performance enhancement, where sports engineering plays a crucial role.

What Is Sports Engineering?

Sports engineering encompasses the research, design, development, and testing of sports equipment, apparel, facilities, and performance technologies. It draws from a broad range of engineering domains:

- Mechanical engineering contributes to the dynamics of balls and gear.

Interdisciplinary Nature of the Field

What sets sports engineering apart is its inherently interdisciplinary character. A modern running shoe, for example, is the product of careful biomechanical study, foam and polymer material engineering, aerodynamic analysis, and data feedback from embedded sensors. It's not uncommon to see sports

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Equipment such as tennis racquets, bicycles, golf clubs, and skis, is constantly being redesigned for better performance, comfort, and compliance with sporting regulations.
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engineers working alongside physiologists, sports scientists, product designers, and athletes to co-develop solutions. This collaboration ensures that innovation in sport is human-centred, science-informed, and performance-driven.

Key Domains & Applications

1. Sports Equipment Design

Equipment such as tennis racquets, bicycles, golf clubs, and skis, is constantly being redesigned for better performance, comfort, and compliance with sporting regulations. Engineers apply principles of dynamics, vibration analysis, fatigue testing, and computational fluid dynamics (CFD) to optimise these tools. The design of Formula One cars or Olympic javelins, for example, must comply strictly with weight and shape criteria while maximising aerodynamic efficiency and control.

2. Materials & Manufacturing Innovation

Materials science plays a crucial role in pushing the boundaries of sport. Carbon fibre,

thermoplastics, and shape-memory alloys have led to lighter, stronger, and more flexible equipment. Additive manufacturing (3D printing) now allows rapid prototyping of customised gear for individual athletes. Engineers work to ensure durability, safety, and sustainability through rigorous testing and lifecycle analysis.

3. Biomechanics & Human Performance

The movement of the human body is central to sport. Using motion capture, force plates, and computer modelling, biomechanical engineers analyse how athletes run, jump, swing, or kick. These insights help design ergonomic products and personalised training programmes, reducing the risk of injury and improving efficiency. Biomechanics has been instrumental in refining techniques for activities such as swimming dives, baseball pitching, and sprinting starts.

4. Wearables & Smart Technology

Electronics and software engineers are developing advanced wearable systems that monitor heart rate, hydration, muscle fatigue, and even concussion risk. GPS trackers, accelerometers, and electromyography

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The rise of e-sports and virtual training environments has further brought software and gaming engineers into the fold. Tools such as VR headsets and haptic feedback systems allow athletes to train in controlled, repeatable environments, enhancing skill acquisition and cognitive performance.

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sensors are used to collect real-time performance data. In elite sports, data is analysed using AI and machine learning to detect patterns, predict injuries, and offer coaching insights. This blend of engineering and sport science is revolutionising both training and competition.

5. Sports Infrastructure & Stadium Engineering

From football stadiums to Olympic villages, engineers are responsible for ensuring facilities are structurally sound, energy-efficient, and accessible. Innovations in HVAC systems, retractable roofs, modular seating, and green energy have transformed the fan experience. Moreover, smart stadiums now integrate IoT technology

for crowd management, safety monitoring, and interactive services. Civil and systems engineers work in tandem with architects and urban planners to create multifunctional, sustainable venues.

6. Simulation, Data Science & e-Sports

Computer simulations help model fluid-structure interactions in cycling or ski jumping, while video analysis software assists in tactics and performance reviews. The rise of e-sports and virtual training environments has further brought software and gaming engineers into the fold. Tools such as VR headsets and haptic feedback systems allow athletes to train in controlled, repeatable environments, enhancing skill acquisition and cognitive performance.

Sports Engineering in Action

- In cycling, engineers collaborated with Team GB to develop carbon-fibre track bikes with unique aerodynamic shapes and laser-guided body positioning systems, contributing to British dominance in the recent Olympics.
- Nike's ZoomX Vaporfly shoes, designed with a carbon fibre plate and responsive foam midsole, were developed with the help of biomechanics and materials engineers. They are believed to provide up to a 4% performance boost in long-distance running.
- The Smart Cricket Ball, developed by engineers in Australia and India, integrates sensors to measure spin, speed, and seam position, providing real-time data for coaching and broadcast.
- Japan's Kengo Kuma-designed National Stadium for the Tokyo 2020 Olympics incorporated earthquake-resistant engineering, timber architecture, and sustainable cooling, showcasing the fusion of tradition, modernity, and engineering ingenuity.

Engineering Education & Research

Many universities are now offering courses, research programmes, and degrees in sports engineering. Institutions such as Loughborough University (UK), TU Munich (Germany), and the University of Tsukuba (Japan) are recognised leaders in this. Topics covered include sports materials, biomechanics, instrumentation, modeling, and product development.

Professional bodies such as the International Sports Engineering Association (ISEA) and academic journals such as Sports Engineering provide platforms for knowledge sharing

and innovation. Engineers can also work in collaboration with governing bodies such as the International Olympic Committee (IOC), FIFA, and the NBA to influence regulations and improve fairness through technology.

Challenges & Ethical Considerations

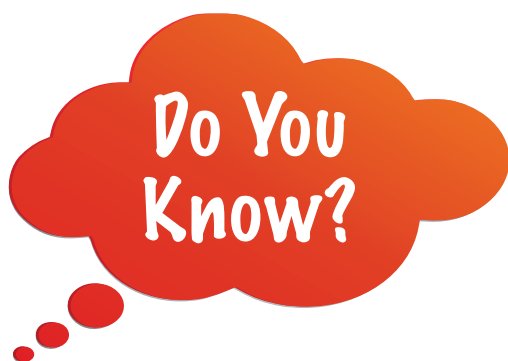
As with any technology-driven field, sports engineering has to navigate ethical questions. For example, does a highly engineered swimsuit give an unfair advantage? Should prosthetic limbs in para-athletics be limited in spring energy return? How do we balance innovation with fairness in competition?

Moreover, engineers must consider environmental impact, from sustainable material use to stadium carbon footprints, and ensure that technology enhances rather than replaces the human element of sport.

Conclusion

Sports engineering is more than just a niche discipline. It is a vibrant, growing field that exemplifies the power of interdisciplinary collaboration. For engineers, it offers a dynamic arena to apply creativity and scientific knowledge in ways that inspire, entertain, and empower people across the globe. Whether designing the next generation of high-performance shoes, developing AI coaching tools, or engineering safer playing surfaces, engineers are shaping the future of sport, one innovation at a time.

As engineering moves into the 21st century, embracing challenges in sustainability, health, and technology, sports engineering stands as a compelling example of how diverse technical skills can make a meaningful difference, not just in laboratories and factories but also on the tracks, fields, courts, and stadiums of the world. 🏆



Artificial Intelligence in Engineering

by

Pang Soo Mooi

1. Malaysia Budget 2025 on Digitalisation, AI Growth and Startup Ecosystem

The Malaysian government's Budget 2025 places strong emphasis on accelerating digitalisation, fostering Artificial Intelligence (AI) adoption, and promoting inclusive growth, according to the Malaysia Digital Economy Corporation (MDEC). The budget reflects Malaysia's intent to solidify its position as a leading digital hub within the ASEAN region and beyond. With Malaysia set to chair ASEAN in the coming year, the initiatives proposed under Budget 2025 are timely, aligning with the nation's strategic goals to drive regional cooperation in AI, digital innovation, and economic transformation. A key focus of Budget 2025 is digital economy, which has become an essential driver of Malaysia's growth and development. By continuing to invest in this area, the government aims to create an enabling environment that

supports both local and foreign investment. High-value sectors such as digital services stand to benefit, with targeted incentives aimed at fostering innovation, increasing productivity, and enhancing Malaysia's competitiveness in the global marketplace.

2. Asean Responsible AI Roadmap (2025-2030)

The ASEAN Responsible AI Roadmap (2025-2030) is developed to provide actionable steps for ASEAN policymakers and stakeholders to create ideal conditions for responsible AI to flourish in the region, as well as for AMS to leverage and enable responsible AI in a meaningful, impactful, and sustainable manner by 2030. The roadmap provides customised and step-by-step guidance for ASEAN governments to prioritise and operationalise responsible AI in an integrated and interoperable manner. This will be done by providing tailored information on two main fronts:

- A. Foundational policy and regulatory factors that foster conducive and enabling environments for responsible AI to emerge in ASEAN.
- B. Targeted actions, initiatives, and outcomes for a constructive and sustainable AI operationalisation that takes AMS's specific needs, priorities, and capabilities into account.

The Roadmap is developed to complement and support ASEAN's ongoing work in AI governance, the upcoming Guidelines on Responsible Development and Use of Generative AI in ASEAN, as well as the ASEAN Guide on AI Governance and Ethics 1 and its key deliverables, including the launch of an AI risk impact assessment template, the development of an AI Governance framework for ASEAN, the creation of an ASEAN Working Group on AI Governance, and the provision of both national and regional level recommendations for ASEAN governments to design, develop, and deploy AI systems responsibly. The development

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The imperative of global governance, in particular, is irrefutable.
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of the ASEAN Responsible AI Roadmap (2025-2030) is anchored in the foundational efforts undertaken in the earlier stages of this project, specifically, the Landscape Overview and Benchmarking Framework which were developed as part of the Research Brief on Responsible AI in Southeast Asia. The Roadmap also leverages the national and regional-level recommendations from the ASEAN Guide on AI Governance and Ethics.

3. Digital Tools Have Already Transformed Product Development – McKinsey

Multiphysics simulation tools allow engineers to evaluate more options more quickly, improving product performance while reducing development time and costs. Today, artificial intelligence and machine learning (AI/ML) technologies have the potential to change the game again, promising faster time to market, better product performance, and disruptive improvements in simulation speed. In 2023, a McKinsey survey conducted in partnership with NAFEMS showed that technological advances, changing market conditions, and increased confidence in advanced engineering simulation tools are shifting user priorities. Respondents said that improved time to market is the primary value driver for the use of simulation in their organisations, surpassing better product performance for the first time.

The survey also revealed a high level of interest in the use of AI/ML simulation tools. Two-thirds of respondents said they had used AI/ML simulation, but only 5% reported using these technologies

at scale. In comparison, the application of traditional simulation tools is ubiquitous in engineering organisations (99%), with just over half of respondents using them at scale.

4. Governing AI for Humanity – UN

AI is transforming our world. This suite of technologies offers tremendous potential for good, from opening new areas of scientific inquiry and optimising energy grids to improving public health and agriculture as well as promoting broader progress on the Sustainable Development Goals (SDGs). Fast, opaque and autonomous AI systems challenge traditional regulatory systems, while ever-more-powerful systems could upend the world of work. Autonomous weapons and public security uses of AI raise serious legal, security and humanitarian questions. Today, there is a global governance deficit with respect to AI. Despite much discussions on ethics and principles, the patchwork of norms and institutions is still nascent and full of gaps. Accountability is often notable for its absence, including for deploying non-explainable AI systems that impact others. Compliance often rests on voluntarism; practice belies rhetoric. The imperative of global governance, in particular, is irrefutable. Raw materials for AI, from critical minerals to training data, are globally sourced. General-purpose AI, deployed across borders, spawns manifold applications globally. The accelerating development of AI concentrates power and wealth on a global scale, with geopolitical and geoeconomic implications.

The development, deployment and use of such technology cannot be left to the whims of markets alone. National governments and regional organisations will be crucial, but the very nature of the technology itself – transboundary in structure and application – necessitates a global approach. Governance can also be a key enabler for AI innovation for the SDGs globally. AI, therefore, presents challenges and opportunities that require a holistic, global approach cutting transversally across political, economic, social, ethical, human rights, technical, environmental & Governing AI for Humanity and other domains. Such an approach can turn a patchwork of evolving initiatives into a coherent, interoperable whole, grounded in international law and the SDGs, adaptable across contexts and over time.

5. Unlocking the Power of AI: A Strong Data Management Foundation – Kearney

Leading users of AI can trace their success to their ability to first build a strong data management foundation. This is why they can use AI to, among other things, effectively automate and streamline processes, improve and personalise customer experiences, boost efficiency, and enhance overall decision-making. With proper data management and governance, other organisations can put in place what they need to experience the same benefits. They can ensure the data used for training AI is accurate, reliable, and up to date, which can lead to improved performance of the AI system. They can establish clear processes for data collection, storage, and use, which can increase transparency and accountability in the AI system. They can adhere to data privacy laws and regulations and ethical principles to avoid legal and reputational risks associated with the improper use of data. They can also demonstrate a commitment to responsible data practices, thus boosting customer trust in their AI systems as well as the products and services they provide. AI is here to stay and only will grow more powerful and valuable in the coming years as Generative AI matures.

To take advantage of this technology and its ever-growing capabilities, organisations need to make sure they focus now on building the data foundation AI needs to push the business forward - profitably, accurately, and ethically.

6. Background of AI in Engineering

The integration of AI into the field of engineering has transformed the way engineers approach problem-solving, design, manufacturing, and system optimisation. Rooted in the broader discipline of computer science, AI has evolved significantly since its conceptual beginnings in the mid-20th century. Its application in engineering has followed a similar trajectory - starting from rule-based systems and gradually advancing toward data-driven, autonomous, and intelligent technologies that are now central to modern engineering practice.

The journey of AI in engineering began in the 1950s and 1960s, when early researchers, inspired by the possibility of replicating human intelligence, developed systems capable of symbolic reasoning. In the decades that followed, particularly the 1970s and 1980s, AI found its first practical use in engineering through expert systems. These systems were designed to mimic the decision-making capabilities of human experts by encoding knowledge in the form of rules and logic. Applications were seen in areas such as fault detection in industrial equipment and advisory systems for design. However, these early AI implementations were often limited by their rigidity, reliance on domain-specific knowledge, and the difficulty of updating and scaling them.

In the 1990s and early 2000s, as computing power improved and data became more accessible, AI in engineering began to shift toward machine learning - a subset of AI focused on data-driven modelling and prediction. This marked a major transition from systems that were manually programmed to those that could learn patterns from data. Engineers began to apply machine learning techniques to problems such as predictive maintenance,

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The rapid rise of AI has created many opportunities globally.
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process optimisation, and quality assurance. Fields such as mechanical, civil, and electrical engineering saw the rise of intelligent systems capable of modelling complex, nonlinear phenomena more accurately than traditional analytical approaches.

The rapid advancement of digital technologies in the 2010s catalysed the widespread adoption of AI across all branches of engineering. Innovations such as deep learning, big data analytics, and cloud computing enabled engineers to harness massive volumes of data from sensors, simulations, and IoT devices. AI became instrumental in smart manufacturing (commonly referred to as Industry 4.0), where it helped automate production lines, monitor equipment in real time, and reduce energy consumption. In design and simulation, AI-powered tools allowed engineers to explore novel solutions through generative design and real-time optimisation. Structural engineers used AI for damage detection and risk assessment, while electrical engineers employed it in energy management and grid optimisation.

7. Ethics of AI – UNESCO

The rapid rise of AI has created many opportunities globally. However, with these rapid changes came profound ethical concerns. These arise from the potential AI systems have to embed biases, contribute to climate degradation, threaten human rights and more. Such risks associated with AI have already begun to compound on top of existing inequalities, resulting in further harm to already marginalised

groups. Getting AI governance right is one of the most consequential challenges of our time, calling for mutual learning based on the lessons and good practices emerging from the different jurisdictions around the world. The aim of the Global AI Ethics & Governance Observatory is to provide a global resource for policymakers, regulators, academics, the private sector and civil society to find solutions to the most pressing challenges posed by AI. Be it in genetic research, climate change, or scientific research, UNESCO has delivered global standards to maximise the benefits of the scientific discoveries, while minimising the downside risks, ensuring they contribute to a more inclusive, sustainable, and peaceful world. It has also identified frontier challenges in area.

8. AI Revolutionising Preventive Maintenance

AI is revolutionising preventive maintenance for machinery and moving plants by providing intelligent, data-driven solutions that enhance reliability, safety, and efficiency. Traditional maintenance practices often rely on fixed schedules or reactive approaches, which can result in unexpected equipment failures and costly downtime. AI offers a more advanced and proactive alternative by enabling predictive maintenance based on real-time data analysis. Using sensors installed on machinery, AI systems can continuously monitor key parameters such as temperature, vibration, pressure, and energy consumption. Machine learning algorithms analyse this data to detect unusual patterns and predict potential faults before they escalate into serious issues. This allows technicians to perform

timely maintenance, minimising disruption and extending the lifespan of equipment. AI also optimises maintenance schedules by considering actual operating conditions, machine usage, and historical data, helping to reduce unnecessary servicing. In addition, AI-powered computer vision systems can perform visual inspections to identify cracks, corrosion, or misalignments without the need for manual checks, which enhances safety and saves time. By integrating AI into preventive maintenance strategies, industries can reduce costs, improve equipment availability, and ensure safer operations. As AI technologies continue to evolve, their role in supporting efficient and intelligent maintenance practices will only become more significant across various sectors.

9. AI in Agriculture Industry

AI is revolutionising the agriculture industry by enhancing productivity, sustainability, and decision-making through data-driven solutions. One of the most impactful advancements is precision agriculture, where AI-powered sensors, drones, and satellite imagery are used to monitor soil health, crop conditions, and weather patterns in real-time. This allows farmers to optimise irrigation, fertilisation, and pest control, resulting in higher yields and reduced waste.

Another key development is AI in pest and disease management, where machine learning models predict outbreaks based on environmental data, enabling early intervention with minimal chemical use. AI-driven robotics is also transforming labour-intensive tasks. Autonomous tractors, planters, and harvesters now perform field operations with high efficiency and accuracy. Moreover, AI-powered crop recommendation systems, such as AgroXAI, analyse climate and soil data to guide farmers in selecting the most suitable crops, improving decision-making and resilience against climate change. In aquaculture and indoor farming, AI monitors water quality, light, and nutrient levels to ensure optimal growing conditions. These technologies are reshaping how food

is grown, managed, and harvested, making agriculture more sustainable and data-smart. As AI continues to evolve, its role in agriculture will be pivotal in addressing global food security and resource management challenges.

10. AI Transforming Construction Site Safety – Netguru

Construction sites are notoriously hazardous environments, but integrating AI in construction is a game-changer in enhancing safety. Real-time hazard detection systems use advanced technologies such as computer vision, wearable technologies, and proximity warning systems to identify potential dangers before they lead to accidents. These AI-powered tools continuously monitor construction site conditions and worker behaviour, proactively identifying unsafe actions and improving safety outcomes. Wearable technologies such as smart helmets and smart vests are another significant innovation. These devices monitor worker behaviour and environmental conditions in real time, providing immediate feedback to construction professionals and alerting them to potential safety hazards. The wealth of data collected by these wearables enables construction companies to make informed decisions and implement preventive measures more effectively. AI systems are not just reactionary but also proactive. AI algorithms analyse historical safety data to predict and prevent accidents before they occur. This proactive approach to safety monitoring ensures that construction firms can address potential issues well before they become critical, significantly reducing the risk of injury. Additionally, AI enhances safety by providing insights that help improve overall safety measures. The overall impact of AI technologies on construction site safety cannot be overstated. AI in construction not only enhances safety but also improves decision-making and ensures better overall project outcomes. Integrating AI solutions into safety protocols helps create safer work environments and fosters a culture of safety that benefits everyone involved. 🧐

What Others Say...

Artificial Intelligence in Engineering

by
Samniang Saenram

1. AI in Smart Infrastructure - UN-Habitat & World Bank

World organisations such as UN-Habitat, the World Bank, and ISO/IEC have issued protocols and recommendations for AI in smart cities and sustainable infrastructure planning. The intersection of AI, urban engineering, and environmental resilience is a key area of focus for many global initiatives.

UN-Habitat's People-Centred Smart Cities framework calls for ethical AI deployment in urban environments. It emphasises inclusivity, public transparency, and governance for AI solutions such as predictive traffic control, autonomous public transit, energy efficiency modelling, and AI-driven urban design. These guidelines are crucial for engineers planning transportation, utilities, and housing systems.

The World Bank's Digital Development Global Practice promotes AI adoption in developing regions through capacity-building in geospatial AI, satellite imaging for slum mapping, and flood prediction modelling. The World Resources Institute (WRI), a partner, supports urban engineers in using AI to monitor carbon emissions and water distribution.

On standards, ISO 37122:2019 (Indicators for Smart Cities) and ISO/IEC JTC 1/SC 42 include AI-specific data governance protocols for public infrastructure, smart sensors, and automated control systems.

Real-world applications include AI-powered digital twins of urban areas to simulate disaster scenarios, optimise zoning decisions, and manage energy use in buildings.

In Malaysia, initiatives under the Malaysia Smart City Framework (2021-2025) incorporate AI in waste management, traffic light automation, and flood monitoring systems - guided by data policies and protocols rooted in ISO and ITU recommendations.

This convergence of AI with environmental and urban protocols ensures that engineers develop technology-enabled cities that are smart, sustainable, and citizen-centric.

2. Cybersecurity & AI: Protocols and Global Standards - ITU

AI has emerged as a powerful tool in cybersecurity, enabling engineers and system designers to detect threats, automate response mechanisms, and defend critical infrastructure. The growing dependence on AI in national infrastructure systems has led to international protocols and oversight from global institutions such as the International Telecommunication Union (ITU), NIST (National Institute of Standards & Technology, USA), and ENISA (European Union Agency for Cybersecurity).

The NIST AI Risk Management Framework (2023) outlines best practices for integrating

AI safely in cybersecurity operations. This includes protocols for secure-by-design AI models, threat modelling, adversarial robustness, and risk mitigation in machine learning pipelines. NIST also coordinates with the National Cybersecurity Centre of Excellence (NCCoE) to guide industries on securing AI workloads in cloud and edge environments.

In Europe, ENISA has published guidelines on AI Threat Landscapes, categorising potential cyber threats and proposing monitoring strategies for AI systems, especially in industrial and civil infrastructure. These documents support engineers working on IoT-enabled smart buildings, pipelines, or transport systems.

The ITU, via its AI for Good initiative, promotes cybersecurity in AI used for public utility systems. It emphasises international cooperation, data sovereignty, and trust frameworks.

In practical terms, engineers are using AI to automate anomaly detection in SCADA systems, monitor cybersecurity in smart grids, and predict hardware vulnerabilities. The protocols developed by these agencies ensure engineers follow consistent and safe practices while embedding AI in critical infrastructure.

3. AI in Industrial Automation - IEC & IEEE

In the realm of industrial and manufacturing engineering, AI is revolutionising productivity through predictive maintenance, robotic automation, and process optimisation. Key protocols and standardisation efforts are led by bodies such as IEC (International Electrotechnical Commission), ISO, and IEEE.

IEC TC 65 (Industrial Process Measurement, Control & Automation) provides core standards on the safe integration of AI into industrial systems. The upcoming IEC 62832 series (Digital Factory Framework) outlines digital twin and AI adoption across process control and smart factories.

ISO/IEC 24029 offers techniques for assessing AI robustness, reliability, and uncertainty in industrial settings - key for engineers who integrate machine vision or autonomous quality control systems. The ISO 50506 standard further supports functional safety in human-machine collaboration, including collaborative robots (cobots) powered by AI.

IEEE P2851 is working on the standard for AI algorithm life-cycle in industrial automation, ensuring traceability and ethical development. These protocols are critical to engineers in ensuring AI-driven machines do not breach safety thresholds or introduce downtime risks.

Multinational platforms such as the World Economic Forum's Global Lighthouse Network promote AI in manufacturing excellence, especially in emerging economies. This network supports pilot projects and protocol sharing for AI deployment in precision engineering, energy management, and logistics automation.

Globally, engineers are applying AI protocols to automate CNC machining, conduct AI-assisted defect detection, optimise logistics using reinforcement learning, and simulate full production lines virtually using neural networks. Adhering to these standards ensures a safe, scalable, and globally accepted practice of AI in manufacturing engineering.

4. AI in Energy Systems - IEA

The role of AI in energy engineering, particularly in smart grids, renewable forecasting, and energy efficiency, has been formalised by world agencies such as the International Energy Agency (IEA), International Renewable Energy Agency (IRENA), and IEEE.

The IEA promotes AI for clean energy transitions. In its 2022 report, Digitalisation and Energy, it emphasises real-time analytics, AI-assisted load forecasting, and predictive control systems as key to stabilising intermittent renewable energy sources. The IEA Energy

Efficiency Digitalisation Protocol guides engineers on the design of AI systems for grid efficiency, energy audits, and emission reductions.

IRENA supports AI in predictive wind/solar output modelling and AI-optimised microgrids in off-grid areas. Their 2021 publication, Smart Grids & Renewables, offers frameworks for integrating machine learning into control systems for solar inverters, battery management, and decentralised energy sharing.

IEEE Smart Grid Standards Committee contributes with guidelines such as IEEE 2030.5 for smart energy profiles and IEEE 1547 for distributed energy resources, many of which now include AI extensions for decision support, anomaly detection, and energy theft prevention.

Applications include AI algorithms for load forecasting, grid failure prediction, AI-enabled demand response systems, and optimising energy use in buildings. In South-East Asia, the ASEAN Plan of Action for Energy Cooperation (APAEC) promotes AI in regional grid interconnection and real-time optimisation.

These AI protocols ensure that engineers align energy innovations with global decarbonisation goals, energy justice, and grid reliability.

5. AI in Healthcare - Role of Biomedical Engineers

AI is rapidly transforming the healthcare sector, offering unprecedented capabilities in diagnostics, treatment planning, patient monitoring, and operational efficiency. From AI-driven imaging analysis to predictive models for disease outbreaks, the integration of AI is reshaping modern medicine. However, this technological revolution also brings critical questions on safety, ethics, and regulation. Biomedical engineers are uniquely positioned to bridge the gap between engineering innovation and clinical application, ensuring that AI

technologies are safe, effective, and compliant with regulatory standards.

The most prominent AI application in healthcare is medical imaging diagnostics. Deep learning algorithms, particularly convolutional neural networks (CNNs), are used to detect abnormalities in X-rays, MRIs, and CT scans, ranging from tumours to fractures, with accuracies rivaling expert radiologists. Companies such as Aidoc and Zebra Medical Vision have already deployed AI systems in clinical radiology for real-time image interpretation.

In predictive analytics, AI models process vast patient datasets to forecast disease progression, identify at-risk populations, and personalise treatment plans. For instance, machine learning is used to predict sepsis in ICU patients hours before symptoms manifest, improving outcomes and reducing mortality.

AI is also revolutionising robot-assisted surgery, where systems such as the da Vinci Surgical System, use AI to enhance precision and reduce recovery time. In drug discovery, AI accelerates the identification of potential compounds by analysing molecular structures and simulating biochemical interactions. Natural language processing (NLP) is increasingly used to extract insights from unstructured clinical notes and research papers.

Additionally, virtual health assistants and chatbots use AI to offer preliminary diagnoses and guide patients, reducing the burden on frontline healthcare providers. These technologies are increasingly integrated with telemedicine platforms, enabling remote care, especially in underserved regions.

Biomedical engineers play a pivotal role in the design, validation, and clinical integration of AI technologies in healthcare. Their interdisciplinary expertise allows them to bridge the gap between computational innovation and biological systems, ensuring that AI tools meet both technical and clinical standards.

At the development stage, biomedical engineers collaborate with data scientists to curate medical datasets, select appropriate machine learning models, and incorporate clinical parameters into algorithm design. Their understanding of anatomy, physiology, and disease pathology ensures that AI models are contextually relevant and clinically applicable.

In device engineering, they work on integrating AI into wearable sensors, diagnostic instruments, and robotic systems. For example, AI-powered ECG monitoring devices, fall detection wearables, and smart infusion pumps are all innovations requiring the expertise of biomedical engineers in sensor calibration, signal processing, and safety mechanisms.

Biomedical engineers also contribute to regulatory submissions by conducting validation studies, preparing risk assessments, and generating performance metrics (e.g., sensitivity, specificity, AUC scores). Their documentation is essential for FDA or CE Mark approval.

6. AI in Engineering Education & Professional Development - UNESCO

World academic networks, engineering societies, and global education agencies are revising engineering education to prepare professionals for AI-centric roles. This includes updated curricula, continuing professional development (CPD), and ethical training.

The UNESCO Engineering Report 2021 recommends integrating AI into undergraduate engineering programmes, emphasising interdisciplinary skills, ethics, and hands-on simulation. UNESCO promotes global collaboration in AI engineering education, particularly in developing countries.

The World Federation of Engineering Organisations (WFEO) and American Society for Engineering Education (ASEE) have developed

CPD programmes that include AI literacy, data analytics, and ethical engineering design. They encourage engineers to achieve competency in AI tools such as MATLAB, TensorFlow, and AutoML.

The Royal Academy of Engineering (UK) and National Academy of Engineering (USA) sponsor fellowship programmes and workshops for AI adoption in civil, environmental, and industrial disciplines. These efforts bridge gaps between traditional engineering and AI-powered design.

Platforms such as Coursera, edX, and MITx have partnered with top institutions to provide certification programmes on AI for engineers, covering topics such as AI in systems modelling, autonomous robotics, and ethical deployment.

In Malaysia, IEM, UTM, and MMU have introduced AI-focused engineering modules and research grants, while MRANTI promotes AI tech transfer to local industries.

Standardising education pathways and professional learning around AI help ensure engineering ethics, safety, and effectiveness are preserved as the field transforms.

7. Ethical & Regulatory Governance of AI in Engineering - UNESCO & OECD

As AI systems become embedded in engineering projects, ethical considerations, legal compliance, and human oversight protocols are becoming mandatory. Key guidance comes from the UNESCO Recommendation on the Ethics of AI (2021), the OECD AI Principles, and the EU AI Act (forthcoming).

The OECD recommends engineers follow principles of transparency, robustness, and human-centric design. It also advocates impact assessments before AI deployment in high-risk systems such as transportation, healthcare infrastructure, or utilities.

The EU AI Act classifies AI systems by risk category. Engineering applications such as autonomous drones, smart elevators, and AI

“ Collaborative platforms such as OpenAI’s Codex, AutoDesk’s Generative Design, and Siemens NX AI are helping engineers rapidly prototype AI-assisted models. ”

traffic controls fall under high-risk, requiring documentation, oversight, and audit trails.

UNESCO emphasises bias mitigation, data privacy, and human oversight in AI applications. Engineers must ensure algorithms used in public infrastructure or smart buildings do not introduce inequities or safety gaps.

Professional bodies such as IEEE (via its Ethically Aligned Design project) and ISO/IEC JTC 1/SC 42 contribute to design principles and audit protocols for AI systems embedded in engineering works.

In practice, engineers are expected to maintain algorithmic traceability, conduct risk-benefit evaluations, and ensure fail-safe mechanisms in AI-enabled designs. Adherence to these ethics protocols aligns engineering practices with human rights and global trust frameworks.

8. Future Trends & Global Collaboration in Engineering AI - WEF

The trajectory of AI in engineering is shaped by emerging technologies such as edge computing, generative design, quantum-AI simulations, and self-healing infrastructure. Leading global efforts are coordinated by WEF, OECD, ITU, and regional alliances such as ASEAN and the African Union.

The World Economic Forum’s AI Toolkit for Cities and AI Governance Alliance shape global collaboration on AI-driven engineering projects, encouraging open data, interoperability, and cross-border protocol harmonisation.

The OECD AI Policy Observatory tracks global R&D funding, legislation, and capacity-building related to AI in engineering-intensive sectors such as water, construction, and transportation.

ASEAN’s AI Guide 2023, jointly developed with Japan and South Korea, promotes shared AI infrastructure for smart ports, renewable energy, and sustainable construction.

Research in AI-driven materials discovery, autonomous construction, and zero-energy infrastructure is gaining traction in institutions such as MIT, Tsinghua University, and Fraunhofer Society, many of which contribute to open-source AI engineering libraries.

Collaborative platforms such as OpenAI’s Codex, AutoDesk’s Generative Design, and Siemens NX AI are helping engineers rapidly prototype AI-assisted models.

With unified global collaboration, engineering can embrace AI, not as a disruptive force, but as a creative enabler of safer, more efficient, and more equitable infrastructure systems. 🤖

Sustainable Water Engineering: Applying the Latest Global Protocols to Real-World Water Systems

by
Ir. Chia Yew Fai

Water is fundamental to life, economic development, and environmental sustainability. However, escalating population growth, urbanisation, industrialisation, and climate change are straining water resources globally.

Sustainable Water Engineering (SWE) has emerged as a vital field to address these complex challenges by integrating technological innovation with ecological stewardship. The outcomes of the United Nations Water Conference 2023 marked a significant step forward, as global leaders, scientists, and policymakers forged new protocols to enhance water governance, resilience, and equity. This article explores how these latest protocols are being applied to real-world water systems to advance the goals of SWE.

UN Water Conference 2023

The first event of its kind in nearly five decades, the UN Water Conference 2023 underscored the urgency of accelerating progress towards Sustainable Development Goal 6 (SDG 6): Clean Water and Sanitation for All.

The conference produced a Water Action Agenda, a compendium of voluntary commitments and cooperative frameworks designed to operationalise sustainable water management. Key outcomes included:

1. Integrated Water Resource Management commitments across sectors and borders.
2. Nature-based Solutions (NbS) for enhancing water system resilience.
3. Improved Data Governance and Digital Water Systems.
4. Support for Water-Climate Nexus initiatives, linking water strategies with climate action.
5. Enhanced Financing Mechanisms for water infrastructure.
6. Recognition of Water as a Human Right, with stronger emphasis on equity and social justice.

Application of Protocols to Real-World Water Systems

1. Integrated Water Resource Management (IWRM)

The commitment to IWRM fosters a holistic approach to managing water, land, and

related resources. In South Africa's Orange-Senqu River Basin, for example, the application of IWRM protocols has improved cross-border cooperation between South Africa, Botswana, Lesotho, and Namibia. Shared data platforms and stakeholder engagement processes are helping to balance ecological needs with agricultural, industrial, and domestic water demands.

2. Nature-based Solutions (NbS)

NbS emphasises the restoration and preservation of natural ecosystems as core components of water engineering. In New York City's Watershed Protection Program, protocols aligned with the UN Water Conference outcomes have prioritised wetland restoration, forest conservation, and sustainable agriculture practices to maintain high-quality drinking water for millions without costly filtration plants.

Similarly, China's Sponge City Initiative, scaled in line with global best practices, utilises green roofs, permeable pavements, and urban wetlands to enhance urban flood resilience while replenishing groundwater.

3. Data Governance and Digital Water Systems

Real-time data collection and smart water management were strongly advocated at the UN Water Conference. In The Netherlands, the national water authority, Rijkswaterstaat, employs AI-driven monitoring systems and digital twins of water networks to anticipate flood risks and optimise water distribution, demonstrating cutting-edge application of conference protocols.

4. Water-Climate Nexus Initiatives

Linking water management and climate resilience was a central theme of the conference. In Bangladesh, one of the most climate-vulnerable nations, new protocols have driven the integration of flood control, climate-resilient infrastructure, and community-based adaptation in the Delta Plan 2100. This long-term vision demonstrates how water engineering can buffer climate impacts while fostering sustainable development.

5. Financing Sustainable Water Infrastructure

The conference highlighted the need for innovative financing, particularly in the Global South. The Green Climate Fund and blended finance models are now used to fund decentralised water treatment systems in Kenya and Uganda, providing affordable, clean water to underserved communities and advancing local water security.

6. Equity and Human Rights

Recognising water as a human right, protocols emphasised inclusive access and participatory governance. In Brazil's semi-arid north-east, community-driven water harvesting and storage systems are being implemented under frameworks aligned with the Water Action Agenda, empowering marginalised populations to secure reliable water access.

7. Challenges and Opportunities

Despite promising applications, several challenges remain. Data disparities, funding gaps, political inertia, and the need for capacity building can slow progress. However, the momentum from the UN Water Conference has catalysed stronger public-private partnerships, interdisciplinary collaboration, and citizen engagement, the cornerstones of a resilient water future.

8. Butterfly Effect Coalition in Engaging Civil Society

While much attention in the United Nations Water Conference 2023 was given to governmental pledges and international frameworks, a crucial force behind the conference's momentum and outcomes was civil society.

At the heart of this mobilisation stood the Butterfly Effect Coalition, a global alliance of non-governmental organisations (NGOs), community groups, and advocacy networks dedicated to amplifying the voice of civil society in water governance. Established in 2010, the coalition proved instrumental in shaping the 2023 conference agenda, promoting inclusive decision-making, and calling for long-overdue institutional reforms in the water sector.

The Butterfly Effect Coalition was founded at the 6th World Water Forum in Marseille in response to the under-representation of grassroots actors in global water dialogues. With over 140 member organisations in Africa, Asia, Latin America, Europe, and North America, the coalition's primary aim is to advocate for equitable, inclusive, and sustainable water governance. It specifically promotes the recognition of water as a human right and the importance of decentralised, community-led water solutions. The coalition takes its name from the metaphor of a butterfly's wings causing a ripple effect, signifying how small, local actions can bring about large-scale systemic change.

In preparation for the UN Water Conference 2023, the Butterfly Effect Coalition undertook an extensive global consultation process. Through regional workshops, online forums, and policy dialogues, it collected input from hundreds of civil society actors. These consultations culminated in a unified Policy Position Paper, which outlined five strategic demands: Enhancing political will, improving governance structures, promoting active citizen engagement, ensuring transparent financing, and reinforcing international cooperation on water issues.

Its efforts were not limited to advocacy documents. It played a proactive role in organising preparatory sessions and high-level meetings in the lead-up to the conference, particularly during events such as the World Water Forum in Dakar. This groundwork laid the foundation for strong civil society presence at the UN event in New York.

At the UN Water Conference 2023, the Butterfly Effect Coalition made its mark through a combination of strategic lobbying, high-profile events, and coalition-building. A delegation of 17 coalition members participated in key sessions, including dialogues with ministers from The Netherlands, France, Germany, South Africa, and Colombia, as well as meetings

with UN Special Rapporteurs on water and indigenous rights. The coalition also helped co-organise side events, most notably From Mar del Plata to the UN 2023 Water Conference: Where do we go?

At the conference, it presented the Civil Society Water Manifesto which highlighted the collective voices of marginalised communities and demanded structural reforms such as the appointment of a UN Special Envoy on Water, regular intergovernmental reviews, and a global water information system. Many of these demands were reflected in the formal outcomes of the conference, including the Water Action Agenda, which recorded over 800 voluntary commitments of which 43% were submitted by NGOs, many under the Butterfly Effect umbrella.

Recognising that declarations must translate into action, the Butterfly Effect Coalition has continued its advocacy efforts beyond the conference. It spearheaded a global civil society open letter, co-signed by over 130 organisations, demanding follow-through on the conference's pledges. The letter emphasised the urgency of giving water "a political home" within the UN system by institutionalising leadership and accountability mechanisms.

Conclusion

SWE is at the forefront of addressing the world's complex water challenges. The latest protocols from the UN Water Conference 2023 provide a comprehensive and actionable framework for advancing this mission. As real-world examples illustrate, integrating IWRM, NbS, digital innovation, climate adaptation, financing mechanisms, and equity considerations is transforming water systems globally. Continued commitment, innovation, and collaboration will be essential to ensure that the promises of these protocols translate into lasting water security for people and ecosystems alike. 🌱



Hat Yai is very popular with tourists, especially Malaysians, for its relatively lower cost of living and cheaper merchandise.



Alternating Odd-Even Date Parking Control in Hat Yai: A Practical Solution for Narrow Streets

by
Ng Li Li

Hat Yai, the largest city in southern Thailand and a major commercial hub near the Malaysian border, is renowned for its bustling streets, traditional markets, and dense urban layout. While its economic vibrancy is a point of pride, its narrow road infrastructure, especially in older districts and market zones, has long posed a challenge for effective traffic management.

In response, local authorities in Hat Yai have implemented a simple yet effective system: Odd-even date-based street parking control, a method that alternates the use of street-side parking based on the calendar date.

Malaysians are flocking to Southern Thailand for nature tours and Hat Yai is ideal as it's near Malaysia and trains offer a convenient, seamless ride.

Odd-Even Day Parking

Many of the roads in Hat Yai are only wide enough to allow one lane of moving traffic. As parking on both sides would create blockages, the municipality has enforced a



Signboard indicating the days that cars are not allowed to park.
The sign here means no parking on even days of the month.

rotational parking rule. This rule specifies that on odd-numbered dates (1st, 3rd, 5th etc), motor vehicles may park only on one side of the street, and on even-numbered dates (2nd, 4th, 6th etc), they must park on the opposite side.

The direction of permitted parking is usually designated by signs in Thai (e.g., “ห้ามจอดวันคี่” or No Parking on Odd Days), often with red and white curb paint or vertical signage. This allows authorities to maintain a clear lane for moving traffic at all times while still ensuring parking space for local businesses and residents on a rotating basis.

The older districts, particularly near Kim Yong Market, Niphat Uthit roads, and other commercial alleys, are not designed for heavy traffic. Cars, delivery vehicles, motorcycles, and tuk-tuks all compete for space. In the absence of wider roads or multi-storey car parks, roadside parking remains the most accessible solution for local residents and shop owners.

Without a control system, vehicles parked on both sides of these streets would mean insufficient space for moving vehicles, often resulting in traffic gridlocks, blocked emergency access, and conflicts between drivers.

The alternating system ensures that at least one side of the street is clear each day, enabling vehicles to pass through smoothly.

To maintain order, the local traffic enforcement teams and municipal police patrol these areas regularly. Drivers who violate the odd-even parking rules are fined and, in many cases, vehicles are clamped. The standard penalty can range from ฿500 to ฿1,000 (RM65 to RM135), with an additional charge for removing the wheel clamp. These penalties are significant enough to ensure compliance.

There is also an incentive-based compliance option, where drivers can legally park on designated streets by paying a small daily



Parking lots on one side of the road are left vacant.

parking fee of around ฿10 (RM1.30). This token sum helps maintain the system's sustainability while keeping the streets orderly.

While the system is generally seen as practical and beneficial, newcomers and tourists may find it confusing, especially when the signage is in Thai only. As a result, those unfamiliar with the rules may unknowingly park on the wrong side and end up paying a penalty.

Enforcement consistency is also critical. Periods of lax oversight will lead to increased violations and reduce the effectiveness of the system. To combat this, authorities often ramp up patrols during busy seasons, such as festivals and school holidays, when the volume of traffic is higher.

Despite these minor challenges, the local community largely accepts the odd-even

“

As a result, those unfamiliar with the rules may unknowingly park on the wrong side and end up paying a penalty.

”

date parking system as a fair and reasonable compromise. It allows shop owners and households on both sides of the street to share parking availability throughout the month, rather than monopolise one side indefinitely.

The odd-even parking control system in Hat Yai is testament to how low-cost, practical urban traffic policies can be highly effective in managing modern congestion in traditional city layouts. Without requiring massive infrastructure upgrades or complex technology, this method ensures smooth traffic flow, accessible roadside parking, and improved safety in densely packed areas. As more cities in South-East Asia grapple with similar urban pressures, Hat Yai offers a replicable example of efficient, community-based traffic management.

Back home, Malaysia's streetside parking control is a work in progress, balancing modern technological solutions with the practical challenges of enforcement and user behaviour. With increasing urban populations and vehicle ownership, the need for efficient, fair, and sustainable streetside parking management continues to grow, prompting the need for innovations from local governments across the nation. 🇲🇾

Tanah Puteh Bridge, Kuantan under Construction, 1962

by
Cheo Hong Keyong



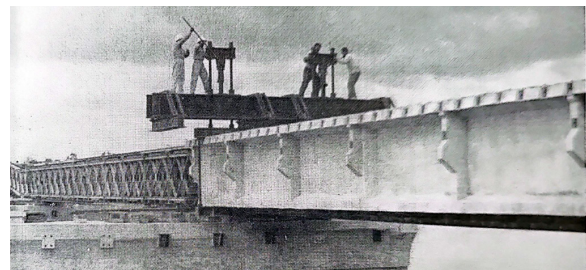
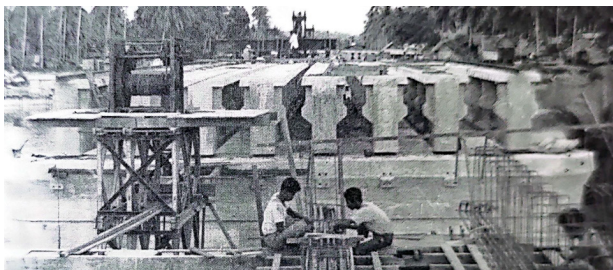
Present view of the bridge

Tanah Puteh Bridge, Kuantan, was constructed in 1962 to replace the ferry service operated by JKR. It was completed in 1963. The reinforced concrete bridge used Raymond piling as foundation for the concrete piers and was laid with precast concrete beams. The construction of the approaches to the bridge were carried out by the JKR work force with their machineries.

The Tanah Puteh Bridge has both historical and infrastructural significance. Located along Jalan Tanah Puteh, a major thoroughfare in Kuantan, the bridge spans the Kuantan River, facilitating connectivity between the city centre and its eastern regions. 📍

Reference

1. Annual report of the PWD 1962



Pictures show Tanah Puteh Bridge during the construction stage

KYODO PIPE STANDARD GALVANISED STEEL CONDUIT



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

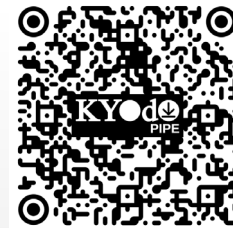
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	MINIMUM		MAXIMUM		MINIMUM		MAXIMUM						MINIMUM		MAXIMUM	
in	mm	in	mm	in	mm	in	mm	in	kg/m	kg/ft	lb/ft	PER INCH	mm	in	mm	in
¾	18.76	0.7387	19.05	0.7500	1.52	0.060	1.63	0.064	0.713	0.217	0.479	16	12.70	0.5000	14.29	0.5625
1	25.11	0.9887	25.40	1.0000	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

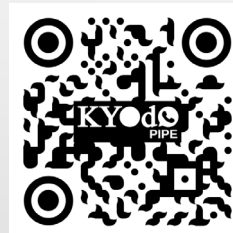
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	MINIMUM	MAXIMUM		MINIMUM	MAXIMUM		MINIMUM	MAXIMUM
mm	mm	mm	mm	kg/m	kg/m	mm	mm	mm
20	19.7	20.0	1.6 ± 0.15	0.643	0.783	1.5	13	15
25	24.6	25.0	1.6 ± 0.15	0.811	0.995	1.5	16	18
32	31.6	32.0	1.6 ± 0.15	1.069	1.301	1.5	18	20

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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