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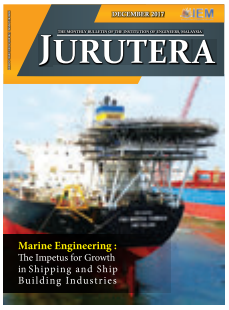







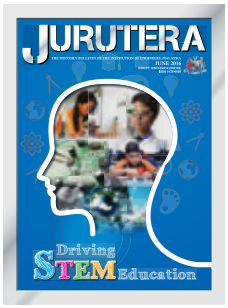

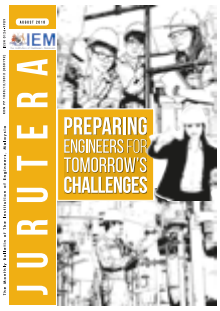

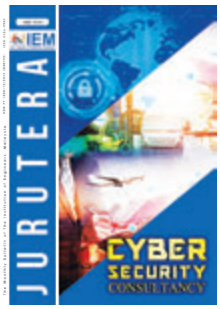

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NOVEMBER 2026

Contents



Ir. Stephanie Sim Hui Kheng
Principal Bulletin Editor

Message from the Editor:

Navigating Malaysia's Next Mineral Frontier

As global demand accelerates for critical minerals, from non-radioactive rare earth elements to strategic battery metals, Malaysia stands at a crucial juncture. Moving beyond raw extraction requires an integrated engineering paradigm, one defined by being smart, safe, and sustainable.

The future of the mineral industry demands intelligent digitalisation. Deploying Internet of Things, AI-driven exploratory analytics, and advanced process automation elevates operational efficiency while establishing value-added midstream and downstream ecosystems. Yet technological progress is meaningless without safety. Rigorous geotechnical risk frameworks, zero-harm protocols, and real-time structural monitoring must safeguard our workforce and communities. Long-term viability hinges on sustainability.

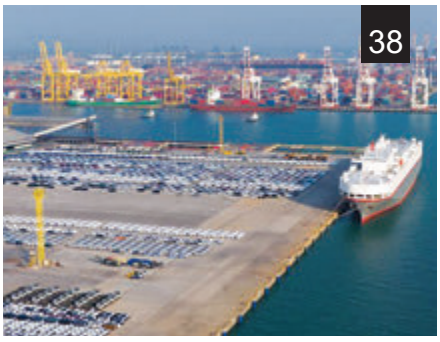
Adopting methods such as in-situ leaching, circular tailing management, and strict decarbonisation targets, ensures alignment with ESG mandates and national blueprints. Engineering excellence must protect ecological integrity while driving economic expansion. By marrying technical rigour with ethical stewardship, we can transform resource wealth into enduring, high-value national capital. ■













Cover Note

05 Smart, Safe & Sustainable: Engineering the Future of Malaysian Mineral Industry

Cover Story

06 Digital & Autonomous Mining for Safety, Productivity & ESG Compliance

Features

14 Green Practices & Climate Change Preparedness in Mining - Turning Finite Resources Into Lasting Value for Malaysia

18 Autonomous & Remote Mining Operations in High-Risk Mining Environments

25 Drone Photogrammetry & AI Assisted Quarry Assessment

30 Towards Holistic Fire Safety Compliance: Media Session with Dato' Sri Nor Hisham Mohammad

Forums

36 Technical Visit to Rahman Hydraulic Tin Sdn. Bhd.

38 Jazan Port & Terminal Capital Planning: Lessons Learnt

40 IEM Golf Tournament 2026

Engineer's Adventure

41 Indigenous Engineering Marvel

Engineer's Lens

43 Floating Sphere

Pink Page

44 Professional Interview

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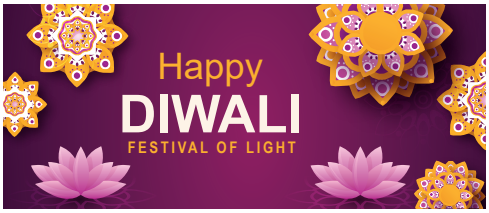

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COVERNote

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Chairman, Oil, Gas and Mining Technical Division (OGMTD)

Smart, Safe & Sustainable: Engineering the Future of Malaysian Mineral Industry

The November 2026 edition of *JURUTERA* is themed Smart, Safe & Sustainable: Engineering the Future of the Malaysian Mineral Industry.

The mineral sector stands at a pivotal juncture. With the National Mineral Industry Transformation Plan 2021-2030, RM10 million allocation for rare earth mapping in Budget 2026, and Malaysia's strategic position in the global rare earth value chain through Lynas LAMP and downstream magnet manufacturing, the industry must engineer beyond extraction to value creation.

This demands smart mining through digitalisation and AI, safe operations through geotechnical excellence and autonomous systems reducing human exposure as well as sustainable development anchored on ESG, rehabilitation and circular economy.

In the Cover Story, Dato' Ir. Dr. Eric Goh talks about Digital & Autonomous Mining for Safety, Productivity and ESG Compliance. He is the first Malaysian Professor in Mining and Vice President of the Institute of Quarrying Malaysia. ■

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Digital & Autonomous Mining for Safety, Productivity & ESG Compliance



The global mining industry is undergoing a major transformation driven by digitalisation, automation, artificial intelligence (AI), and sustainability imperatives. Modern mining operations are no longer solely dependent on conventional extraction methods, but are increasingly supported by data-driven systems, autonomous equipment, predictive analytics, and integrated Environmental, Social & Governance (ESG) frameworks. In Malaysia and across the ASEAN region, the transition towards Digital Mining or Mining 4.0 presents significant opportunities to improve operational safety, productivity, resource efficiency, and environmental stewardship. Emerging technologies such as autonomous haulage systems, digital twins, IoT-enabled monitoring, drone-based surveying, and AI-assisted decision support systems are rapidly reshaping how mines are planned, operated, monitored, and rehabilitated. At the same time, the mining industry faces growing pressure to strengthen ESG compliance, reduce carbon emissions, improve tailings governance, and ensure responsible mineral development aligned with global sustainability goals.

In this issue of JURUTERA, ***Dato' Ir. Dr. Eric Goh*** *talks about the future of digital and autonomous mining technologies, the challenges of industry adoption, and the evolving role of engineers in advancing safe, intelligent, and sustainable mining ecosystems.*



Q. What are the major technological shifts currently transforming the global mining industry?

Dato' Eric Goh: The mining industry is transitioning from conventional labour-intensive operations towards highly connected and intelligent mining ecosystems. Key technological shifts include the integration of Artificial Intelligence (AI), Internet of Things (IoT), autonomous vehicles, robotics, real-time monitoring systems, cloud computing, remote sensing, and digital twins into mining operations.

Mining companies are increasingly adopting data-driven operational frameworks where decisions are supported by predictive analytics, automated control systems, and integrated digital platforms. The emergence of Mining 4.0 reflects the broader Industry 4.0 transformation, enabling mines to become safer, more efficient and environmentally sustainable.

Advanced geospatial technologies, drone-based surveying, autonomous drilling, and AI-assisted orebody modelling are also revolutionising exploration and resource management practices.

Q. How do digital and autonomous technologies improve safety performance in mining operations?

Dato' Eric Goh: Safety remains one of the most critical priorities in mining operations. Digital and autonomous technologies significantly reduce human exposure to hazardous working environments, particularly in underground mines, unstable slopes, confined spaces, and high-risk blasting zones.



> "Digital mining is redefining **safety**, **sustainability**, and **operational intelligence**"

Autonomous haul trucks, remote-controlled drilling systems, and robotic inspection technologies allow hazardous tasks to be conducted without direct human presence. Real-time monitoring systems integrated with IoT sensors can continuously track ground movement, slope stability, gas emissions, equipment conditions and environmental parameters.

AI-assisted predictive systems are increasingly capable of identifying early warning indicators of potential failures, enabling preventive intervention before incidents occur. Wearable technologies and fatigue monitoring systems also contribute towards improving workforce safety and reducing operational risks.

The long-term objective is to move towards predictive and preventive mining safety systems aligned with the industry's "zero harm" aspiration.

Q. How can automation enhance productivity and operational efficiency in modern mining?

Dato' Eric Goh: Automation enables mining operations to achieve higher operational consistency, reduced downtime, and improved resource utilisation. Autonomous equipment can operate continuously with minimal interruptions, allowing 24/7 production capability under controlled operational parameters.

AI-enabled fleet management systems optimise haulage routes, fuel consumption, equipment dispatching, and maintenance scheduling. Predictive maintenance systems reduce unplanned breakdowns and improve equipment reliability through continuous condition monitoring.

Digital platforms also improve ore grade control, production planning, and supply chain integration. Real-time operational dashboards enable mine operators and engineers to make faster and more informed decisions based on live operational data.

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Collectively, these technologies contribute towards increased operational efficiency, reduced operational costs, and enhanced productivity across the mining value chain.

Q. ESG compliance is becoming increasingly important globally. How can digital mining technologies support Environmental, Social & Governance (ESG) objectives?

Dato' Eric Goh: Digital technologies provide important tools for strengthening ESG performance in mining operations. Real-time environmental monitoring systems can continuously track dust emissions, water quality, noise levels, vibration, tailings stability, and carbon emissions.

Digitalisation improves transparency, traceability, and accountability in environmental reporting and regulatory compliance. AI-assisted analytics can support energy optimisation, emissions reduction strategies, and resource efficiency initiatives.



Ir. Razak Yakob, Vice President of The Institution of Engineers, Malaysia (IEM) with Dato' Ir. Dr. Eric Goh

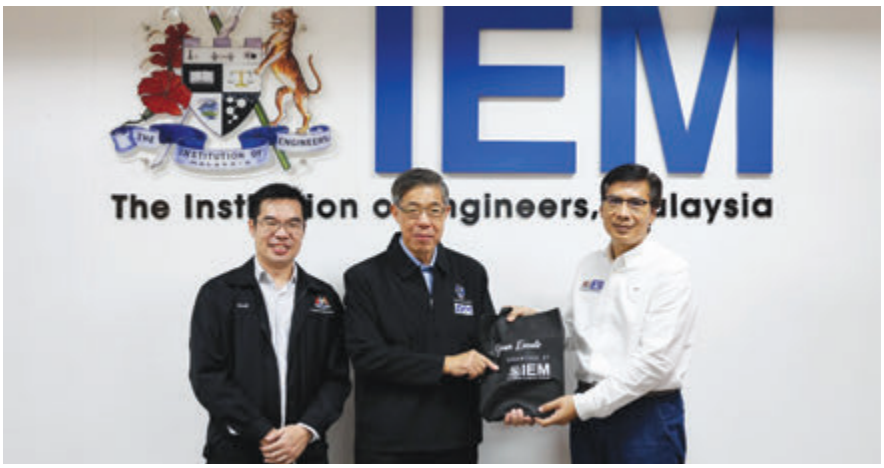
Precision mining techniques enabled by digital technologies also help reduce unnecessary land disturbance, waste generation, and environmental impact. In addition, digital stakeholder engagement platforms can improve communication with local communities and regulators.

As global investors increasingly prioritise ESG-driven investments, digital mining systems are becoming essential for ensuring sustainable and responsible mineral development aligned with international sustainability frameworks and the United Nations Sustainable Development Goals (SDGs).

Q. What are the major challenges the mining industry faces in adopting autonomous and digital systems?

Dato' Eric Goh: One of the primary challenges is the high initial capital investment required for digital infrastructure, autonomous equipment, and integrated monitoring systems. Many mining operations, particularly smaller operators, may face financial limitations in adopting advanced technologies.

Other key challenges include limited digital infrastructure in remote mining regions, cybersecurity risks, integration with legacy operational systems, and data interoperability issues.



Ir. Lee Chang Quan (left) and Ir. Muhamad Her (right) presenting a token of appreciation to Dato' Ir. Dr. Eric at The Institution of Engineers, Malaysia (IEM)

The industry also faces a growing skills gap in areas such as AI, data analytics, automation engineering, robotics, and digital systems integration. Workforce adaptation and change management remain critical considerations, particularly in the transition from conventional operational practices towards digitally enabled mining environments.

> In future, mines will be **data-driven**, **autonomous**, and **ESG-centric**

In tropical regions such as Malaysia, environmental conditions such as heavy rainfall, humidity, and terrain complexity may also pose operational and reliability challenges for certain autonomous technologies.

Q. How prepared is the Malaysian mining sector for the transition towards Mining 4.0?

Dato' Eric Goh: Malaysia is currently at an early-to-intermediate stage of Mining 4.0 adoption. However, there is increasing awareness among industry stakeholders with regards to the importance of digital transformation and sustainable mineral development.

The country possesses significant opportunities in critical minerals, rare earth elements, quarrying, and the potential revitalisation of strategic mineral industries. Emerging technologies can play an important role in improving resource governance, operational efficiency, and ESG compliance.

To accelerate adoption, stronger collaboration between government agencies, universities, research institutions, technology providers, and industry operators will be

essential. The development of national digital mining strategies, technical standards, and workforce development initiatives will also be important to support long-term industry transformation.

Q. What role can engineers play in advancing sustainable and intelligent mining systems?

Dato' Eric Goh: Engineers will play a central role in integrating technology, operational safety, environmental sustainability, and regulatory compliance within future mining systems.

The transition towards intelligent mining requires multidisciplinary collaboration involving mining engineers, geotechnical engineers, electrical engineers, mechanical engineers, mechatronics specialists, software engineers, and data scientists.

Professional engineers must also ensure that autonomous and AI-enabled systems operate within safe, ethical, and accountable engineering frameworks. As digital systems increasingly influence operational decisions, engineering judgement, professional responsibility, and risk governance remain critically important.

Continuous Professional Development (CPD) and lifelong learning will be necessary to ensure engineers remain competent in emerging technologies and sustainability-driven engineering practices.

Q. How important are artificial intelligence and data analytics in the future of mining?

Dato' Eric Goh: Artificial intelligence (AI) and advanced data analytics are expected to become strategic enablers for future mining operations. AI systems can analyse large volumes of operational, geological, geotechnical, and environmental data to support predictive modelling and operational optimisation.

Machine learning technologies are increasingly being used in mineral exploration targeting, orebody characterisation, predictive maintenance, slope stability analysis, and process optimisation.

Digital twins integrated with real-time operational data may eventually enable self-optimising mining systems that continuously adapt operational parameters in response to changing conditions.

However, AI should remain a decision-support tool rather than be used to replace professional engineering judgement. Human oversight, ethical governance, and transparent validation processes will remain essential.

Q. What competencies should future engineers and graduates develop to remain relevant in the evolving mining sector?

Dato' Eric Goh: Future engineers should develop competencies that combine traditional engineering fundamentals with digital and sustainability-oriented capabilities. These include:

- Digital literacy and data analytics.
- AI and machine learning fundamentals.
- Automation and robotics systems.
- GIS and geospatial technologies.
- Remote sensing and digital mapping.
- ESG and sustainability management.
- Cybersecurity awareness.
- Systems engineering and interdisciplinary collaboration.
- Risk assessment and decision-support systems.

Beyond technical competencies, adaptability, critical thinking, communication skills, and ethical leadership will become increasingly important in managing complex intelligent mining systems.

Q. What is your vision for the future of digital and autonomous mining in Malaysia and the ASEAN region?

Dato' Eric Goh: In future, the mining ecosystem in Malaysia and ASEAN is expected to become increasingly intelligent, connected, low-carbon, and sustainability-driven. Autonomous operations, digital monitoring platforms, renewable energy integration, and AI-assisted decision systems will likely become standard industry practices over the coming decades.

The region also has strong potential to become an important hub for sustainable mineral governance and responsible critical mineral development.

The future of autonomous mining should not be viewed solely as workforce replacement but rather as the development of safer, more efficient, and human-centred operational systems where technology enhances engineering capability and operational resilience.

With appropriate governance, talent development, and industry collaboration, Malaysia can position itself as a regional leader in sustainable and intelligent mining development.

Closing Message

Digital and autonomous mining is no longer a future aspiration but an ongoing industrial transformation. Engineers, policymakers, researchers, and industry leaders must work together to ensure technological advancement is balanced with safety, sustainability, ethics, and long-term societal value.

As the mining industry evolves towards more intelligent and ESG-centric operations, engineers will remain at the forefront of shaping responsible and resilient mineral development for future generations. ■



Interviewee's Profile

Dato' Ir. Dr. Eric Goh *is a retired professor from the School of Materials & Mineral Resources Engineering at Universiti Sains Malaysia and the Deputy President of Institute of Quarrying Malaysia (IQM). He is recognised by the Malaysia Book of Records as the 'First Distinguished Mining & Quarrying Engineering Professor' in Malaysia, with over 45 years of experience in digital mining, geotechnology, ESG-driven mineral development and sustainable mining innovation.*

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Green Practices & Climate Change Preparedness in Mining - Turning Finite Resources Into Lasting Value for Malaysia

by:



Mr. Raja Shazrin Shah Raja Ehsan Shah

Chemical Engineer, Founder and Managing Director, Adjunct Professor, sustainability consultant, researcher and policy advisor.

What happens when the last bit of mineral deposits has been extracted in a mine? This is the question behind my support for sustainable mining. A finite resource should build productive industries, skilled people, and communities which are able to prosper beyond the life of the mine. We must protect water, manage environmental damage and pay for rehabilitation along the way.

In an earlier article[1], I wrote about whether "sustainable mining" was a contradiction. My position was clear: Embrace the ambition and put engineering behind it. The resource will run out. The value we create should not disappear with it.

Malaysia's rare earth opportunity can support cleaner technologies and local expertise. Its value depends on extraction, processing, environmental protection, and the people we train. Adding "sustainable" to the brochure is, regrettably, the least demanding part.



Figure 1: Kittilä mine, Finland, 2007. Sustainable mining must address both production and what remains afterwards. Photograph: Agnico-Eagle / Wikimedia Commons, CC0

Opportunity Begins With a Customer

Rare earth elements (REE) matter because of what they enable. Neodymium and praseodymium, sometimes combined with dysprosium or terbium, support powerful permanent magnets in electric motors and wind generators[2]. Their climate relevance does not remove the environmental responsibilities of producing them.

Europe's Critical Raw Materials Act demonstrates the strategic importance of these materials. Its 2030 benchmark includes EU capacity equivalent to at least 10% of annual strategic raw-material consumption for extraction, 40% for processing and 25% for recycling[3].

For selected EU Strategic Projects, permitting timeframes are 27 months for extraction and 15 months for processing or recycling, subject to applicable rules and exceptions. Environmental assessment and community engagement remain required[4]. Governments want minerals sooner; communities need confidence that urgency will not weaken scrutiny.

Malaysia should recognise this opening. But a mineral deposit becomes commercially useful only when there is demand. Recoverable rare earth composition, purity, delivery reliability, and processing cost matter more than headline valuations of material underground.

Sustainable mining therefore influences industrial strategy. Which products can we supply competitively? What capability is missing? Have we included the environmental cost? Mineral abundance alone is not industrial readiness.

Different Extraction Method Changes The Engineering Task

Malaysia's ion-adsorption clays offer one route. Some rare earth ions attach to clay surfaces. In-situ leaching (ISL), passes a solution through suitable material to release them. Then the metal-bearing solution is collected for recovery. Leaving much of the material in place can reduce excavation, hauling and grinding as compared to an open-pit route.

The Ministry of Natural Resources & Environmental Sustainability identifies these deposits in Malaysia's weathered granitic terrains. It links ISL to approved mining schemes,

environmental impact assessment conditions as well as surface-water and groundwater controls[5].

The ground becomes part of the processing system. Engineers must understand solution movement, recovery and possible escape routes. A flowsheet above ground is easier to inspect than a preferential flow path beneath a hillside.

Research in southern China documents groundwater risks from escaping leachate[6]. Groundwater characterisation, reagent accounting and monitoring beyond the extraction zone are therefore essential. The system must remain controllable even when storms change the water balance.

In March 2026, it was reported that an initial Forest Research Institute Malaysia study at a rubber plantation indicated that controlled implementation was possible under strict operating procedures[7]. This supports development within the conditions studied, not equivalent outcomes in every forest ecosystem or catchment.

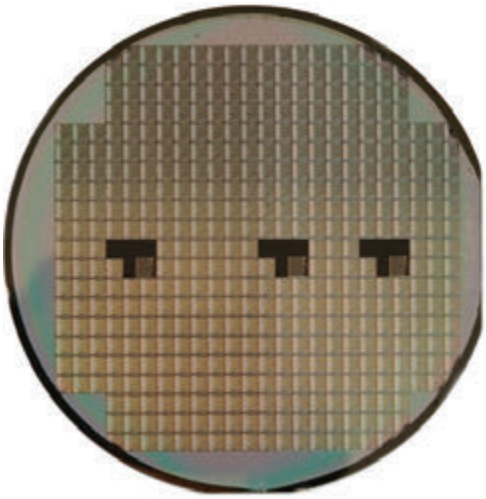


Figure 2: A silicon wafer illustrates the precision required downstream. This is not a photograph of SMD or the Silicon Longhouse. Photograph: Inductiveload / Wikimedia Commons, public domain

Universiti Malaysia Pahang Al-Sultan Abdullah research has modelled magnesium-sulphate leaching at room temperature[8]. Field trials must establish acceptable recovery, solution control, and restoration. A promising model is a reason to run a disciplined trial, not retire the monitoring team.

Advance sustainable mining by establishing what works, identifying limits, and improving through evidence. Judge ISL across the whole system, including downstream separation and rehabilitation. The absence of an open pit is one advantage, not the entire argument.

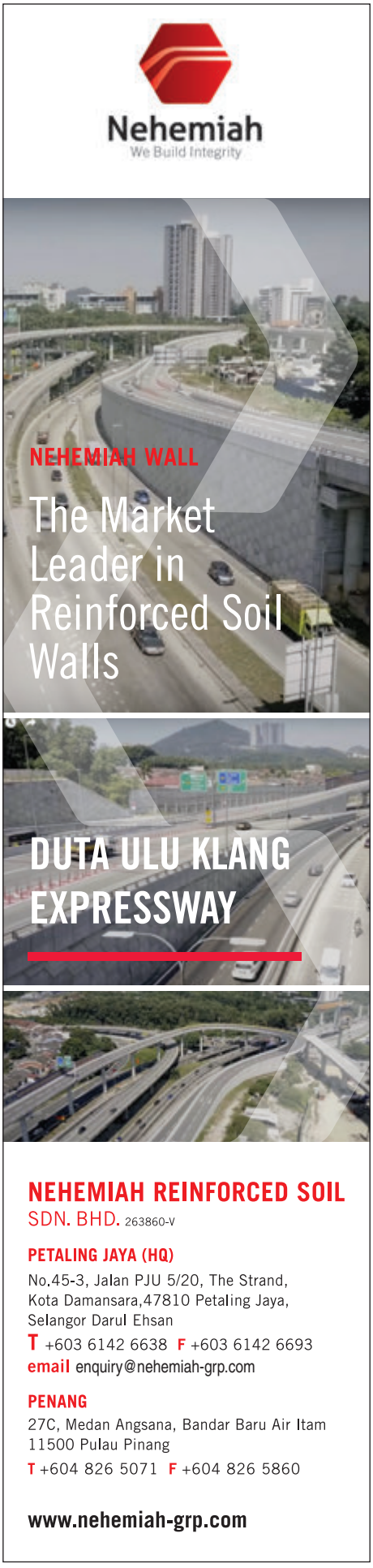
Recover More Value from Every Tonne

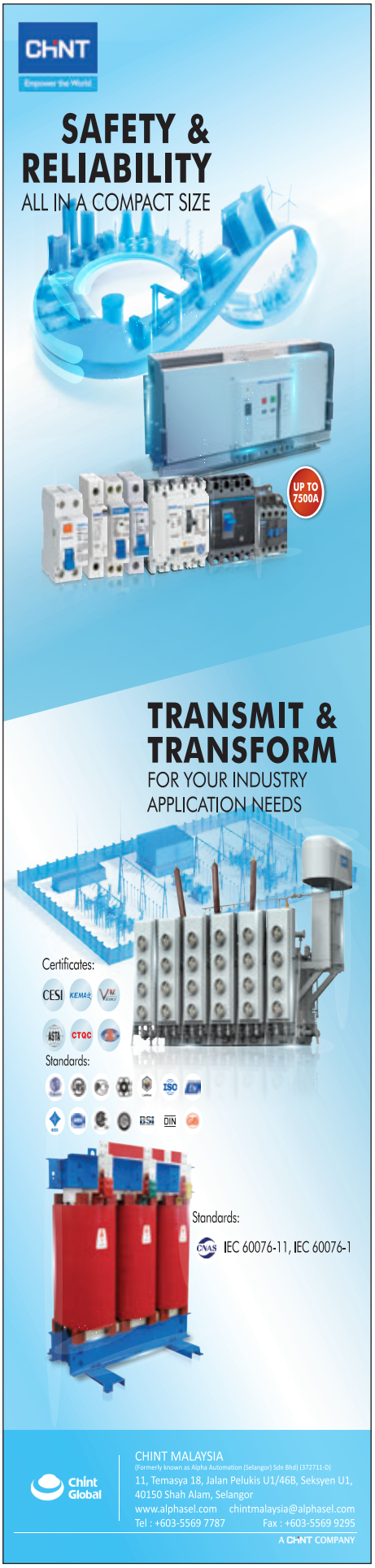
The same thinking applies to conventional mines. Before asking how to power a mill more cleanly, ask whether all materials entering it needs to be ground.

Sensor-based ore sorting removes low-value material before grinding. Australian government guidance identifies sorting and high-pressure grinding rolls as energy-efficiency options[9]. Suitability depends on the ore: Rejecting rock saves little if valuable mineral leaves with it.

Anglo American reported that coarse particle recovery at El Soldado increased copper production by 16% without additional energy[10]. This company-reported, site-specific result illustrated why changing mineral recovery could matter as much as changing the power supply.

Electrification requires the same discipline. Compare equivalent work, include charging and electricity generation, and check power-system capacity. Measure total emissions and emissions per tonne of saleable product. A better ratio does not necessarily mean less carbon entering the atmosphere.





A Mine Must Survive The Climate It Is Helping to Address

These improvements have little lasting value if the operation cannot withstand the local climate. A lower-carbon plant can still flood. An electric pump is not much help when its substation is underwater.

Rainfall affects ISL solution collection and treatment, conventional mines' tailings, slopes, and access roads. Drought can constrain both. Climate preparedness belongs in the original design and investment case, with allowances to be reviewed as knowledge improves.

Translate risks into storage capacity, equipment redundancy, shutdown thresholds and authority to stop production. The Global Industry Standard on Tailings Management connects technical design with accountable management and obligations through closure and post-closure[11].

Treatment, monitoring, and rehabilitation may continue after sales revenue ends. The cost should be included in the mineral price. Leaving the public to bear the cost makes today's product cheaper by charging the taxpayer tomorrow.

Environmental protection belongs inside our definition of value. Strengthening manufacturing while weakening water security will not secure Malaysia's future.

Silicon Longhouse Shows Why Ambition Should Extend Beyond Extraction

Sarawak's Integrated Silicon Longhouse illustrates thinking beyond raw materials. SMD Semiconductor describes a vision that combines global expertise, local talent, and research collaboration to build semiconductor capability in Samajaya[12]. My article connected materials, technology, and sustainability through local capability[13].

Work backwards from industrial needs. Silica-bearing material does not become semiconductor-grade silicon merely by proximity to semiconductor ambition. Impurities must be removed, yields established and products qualified by customers. The Silicon Longhouse vision does not establish a local mine-to-chip supply chain.

Likewise, a mixed rare earth product is only one stage. Separation and consistent materials for demanding applications require further technology and expertise. Each stage requires a commercial and environmental case. More processing creates lasting value only when both work.

Shared laboratories, pilot facilities and specialist training should close these gaps. Their purpose is to build capability that outlasts a particular deposit.

Engineers Must Make The Claim Credible

Financing and customer trust require evidence that performance matches the ambition. This is where frameworks earn their place.

Towards Sustainable Mining (TSM), links commitments to operational protocols and assessment. Its Climate Change Protocol covers strategy, facility management, targets, reporting, and adaptation[14],[15]. The Initiative for Responsible Mining Assurance (IRMA) provides independent mine-site assessment and public reporting[16]. Neither replaces local legal obligations or guarantees every claimed outcome.

Use them to show what has changed – whether performance has improved and the problems that remain. A logo should lead to evidence, not end the enquiry.

This changes the expertise we need. Geometallurgists link deposit variability to recovery and product quality. Hydrogeologists and reactive-transport specialists explain ISL behaviour. Automation engineers control processes while industrial cybersecurity specialists protect them. Lifecycle and product-carbon specialists assess impacts across the production chain.

Materials qualification, separation, and circular-process engineers connect mining to manufacturing and secondary-resource recovery. These require laboratory work and supervised operating experience. Training should leave someone able to improve a process, not merely to explain its sustainability slide.

My goal is for Malaysia to be recognised for sustainable mining through competitive products, capable people, protected water, and properly rehabilitated land. That starts with the next project decision: Will this investment equip Malaysia for the future and have we provided for its consequences?

That is the purpose of championing sustainable mining. The mineral is finite. Our responsibility is to make its contribution last. ■

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IMAGE SOURCES

Figure 1. Agnico-Eagle, Kittilä mine, 12 June 2007. CC0 1.0 public-domain dedication. https://commons.wikimedia.org/wiki/File:Kittilla,_Finland;_Open_Pit_Mine.jpg

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E-NOMINATIONS FOR ELECTION TO FILL VACANCIES FOR THE COUNCIL SESSION 2027/2028

The IEM Council at its 452nd meeting on 20 July 2026 had decided to fill Council vacancies for the Session 2027/2028 in accordance with Article 5.2 of the Constitution via e-Nomination. An election programme has also been approved by the Council for implementation. The following Council vacancies will arise for Session 2027/2028 as a result of Council members retiring at the end of Session 2026/2027.

Office	No. of Vacancies	Term of Office
Vice President	Four (4)	2 sessions (2027/2028 and 2028/2029)
Honorary Secretary	One (1)	1 session (2027/2028)
Honorary Treasurer	One (1)	1 session (2027/2028)
Council Members *Chemical & Other Discipline Representative* *Ordinary Representatives*	 One (1) Ten (10)	 3 sessions (2027/2028, 2028/2029 and 2029/2030) 3 sessions (2027/2028, 2028/2029 and 2029/2030)

E-nomination

All Corporate Members to submit the nomination via the IEM e-nomination portal using the link that will be emailed to Corporate Members on **6 November 2026 (Friday)**. The e-nomination must include all required particulars, the nominee's electronic consent and the Bio-data in the prescribed format and must be submitted no later than 12.00 noon on **5 December 2026 (Saturday)**.

Dato' Ir. Dr. Lim Chow Hock
Election Officer 2026/2027

Autonomous & Remote Mining Operations in High-Risk Mining Environments

by:



Mr. John Low

Senior Consultant at Huawei Global Training Centre (Malaysia), has 20 years of experience in competency development, organisational transformation and strategic HR.

It has long been acknowledged that mining is one of the most dangerous and complex industries in the world. Mining often takes place in high-risk environments with unstable geological conditions, underground hazards, blasting operations, gas leakage, heavy machinery operations, and exposure to hazardous materials.

Meanwhile, demand for minerals, energy resources, and rare earth materials continues to grow in the face of global industrialisation, urbanisation, and digital transformation. This has resulted in an increased demand for mining companies to increase productivity while maintaining cost efficiency, protecting the environment and ensuring the safety of all employees. However, traditional mining processes are still labour intensive, have weak operational systems and lack manual monitoring, so it is a real challenge when considering and balancing these factors.

The mining industry is experiencing four developmental pressures that are inter-connected: Production Safety, Intelligent Automation, Green/ Sustainable Operations and Efficient Management (Figure 1). Safety is still the biggest problem because of the number of accidents reported during drilling, blasting, loading, transportation, collapsed tunnels, and equipment failure.

In addition to operational risks, mining companies need to consider campus and property security in mines as these can help protect employees, facilities, and vital assets. On the other hand, companies also face challenges such as having to modernise the production process by implementing production automation, monitoring automation, and office automation, which will allow better coordination, increased productivity, and greater efficiency in decision making.

These challenges are further exacerbated by environmental sustainability. Traditionally, mining operations are linked to heavy energy use, carbon dioxide emissions, environmental degradation, and pollution. Today, governments, regulators, and society are calling for environmentally responsible mining which is not only economically viable but which also has minimal impact on the environment. As such, mining firms are investing in smart pollution monitoring systems, energy efficient technologies, and eco-friendly operational models to create more sustainable operations.

Safety Imperative

Because of the highly hazardous conditions involved in mining, safety is always a top priority. Mining operations are often conducted in challenging conditions such as areas with limited manoeuvreability, large machinery movement, explosive materials, and hazardous gases. The effects of these risks have been tremendous in terms of human lives lost.

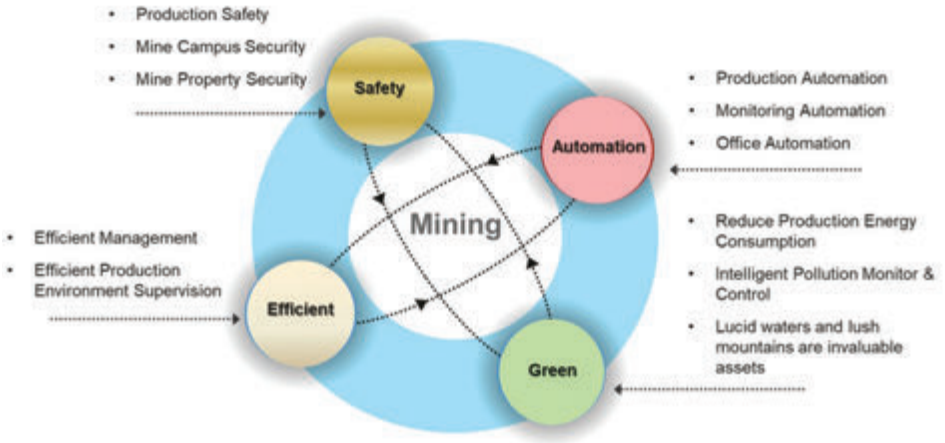

Figure 1: Four major challenges in the development of the mining industry

In China, the National Mine Safety Administration reported that thousands of mining accidents and casualties which occurred in early 2000s were due to unsafe working conditions, labour-intensive operations, and unsound safety management practices. While the accident and fatality rates have slowly decreased with the introduction of tougher government laws, industry consolidation, improved safety supervision, and the increased use of intelligent mining technology, there are still serious safety risks, especially in high-risk underground and open-pit mines. These persistent issues have driven the mining sector to become more autonomous and technologically advanced, using remote monitoring and turning to AI for safety management solutions.

High risk activities such as drilling, blasting, loading, and transportation continue to be the leading causes of mine accidents (Figure 2). Many of these operations involve working in potentially hazardous and unstable conditions, with risks of

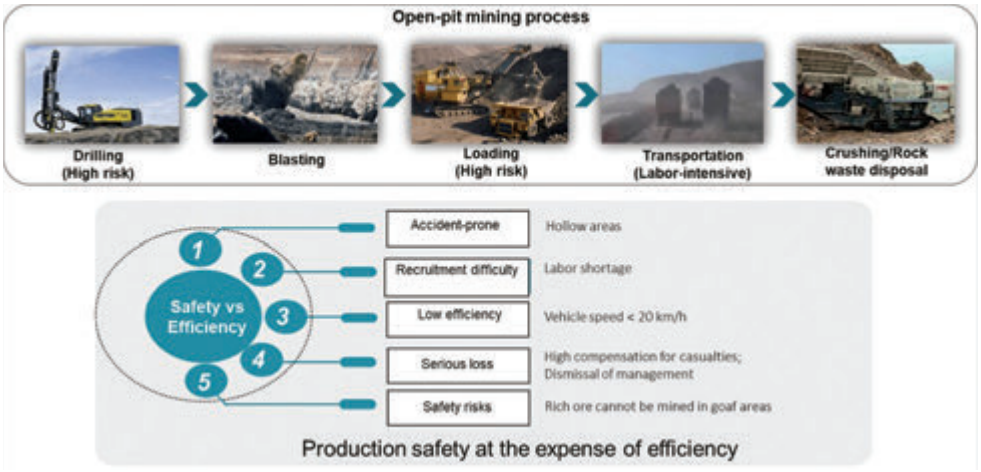

Figure 2: Safety and efficiency challenges in traditional mining operations

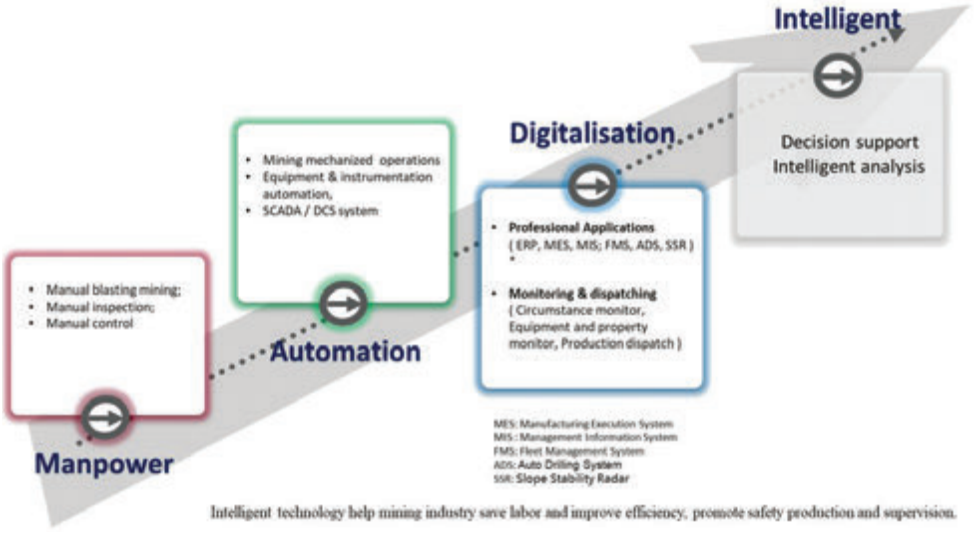

Figure 3: Evolution path from mechanisation to intelligent mining systems

fatigue, visibility restrictions, equipment failure, and human error. In addition, mining companies have structural labour issues, such as the shortage of workers/younger workforce or an older workforce that is less capable physically.

Safety and productivity have long been considered a trade-off in mining. Often, production efficiency was sacrificed for worker safety, causing compromises in operations and creating accident prone environments. But today, technology is making it possible for mining companies to change this by incorporating intelligent systems which not only boost safety but also enhance productivity.

Rise of Autonomous & Remote Mining Operations

Autonomous and remote mining operations are changing the way mining is being carried out. With AI, robotics, the Industrial Internet of Things (IoT) and the introduction of cloud computing and high-speed communications such as the 5G network, mining firms can now remotely manage or fully automate many of the most dangerous operations.

A remote mining operation can be configured to allow workers to operate equipment in hazardous areas from a control centre located a safe distance away. Autonomous systems, on the other hand, enable machines to work independently, such as drilling, hauling, monitoring, and transportation. These technologies offer substantial protection to human life as well as enhance operational accuracy and continuity in hazardous environments.

There has been a gradual development comprising four stages: Mechanisation, automation, informatisation and intelligence (Figure 3). A mechanised mining industry depends heavily on humans and isolated machines. During the automation phase, instrumentation systems, centralised systems of control as well as Supervisory Control and Data Acquisition (SCADA) systems and Distributed Control System (DCS) are added.

Operational visibility is also improved with the use of professional management systems, monitoring technologies, and data integration features in the process of informatisation. With the advancement of AI and predictive analytics, autonomous control, and cloud-based platforms, intelligent mining systems are currently capable of achieving unmanned mining, intelligent decision-making, and proactive risk management. This shift represents a shift in the paradigm from labour intensive mining to intelligent, data-driven, and safety focused mining ecosystems.

Technology the Foundation

The transition toward autonomous mining is fundamentally enabled by advancements in digital and intelligent technologies. Modern mining operations increasingly rely on integrated ICT infrastructure which supports real time connectivity, intelligent analysis, predictive maintenance, and autonomous operational control.

Full Perception, Full Connectivity, and Full Intelligence (Figure 4) are three closely related technological capabilities which enable intelligent mining operations.

At the Full Perception layer, various types of sensors and monitoring devices are installed in the mining field to collect data continuously on operations, environment, and safety. These enable immediate looks into the state of equipment, the stability of the geology, worker safety, gas levels, energy usage, and environmental performance, to create digital underpinnings for smart mining.

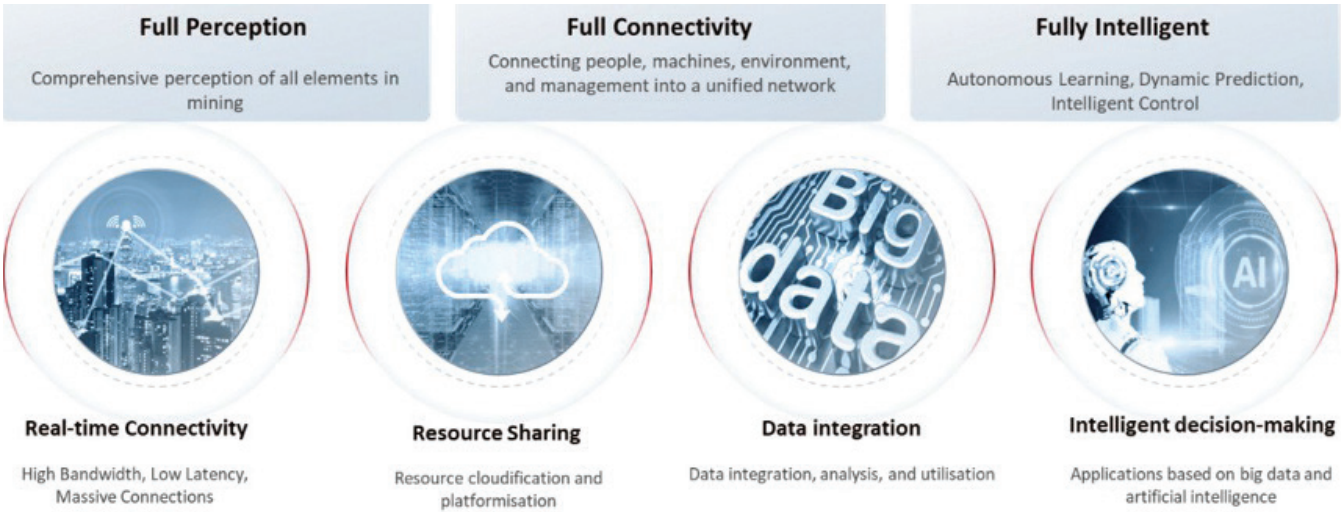

Figure 4: ICT technologies enabling intelligent mining transformation

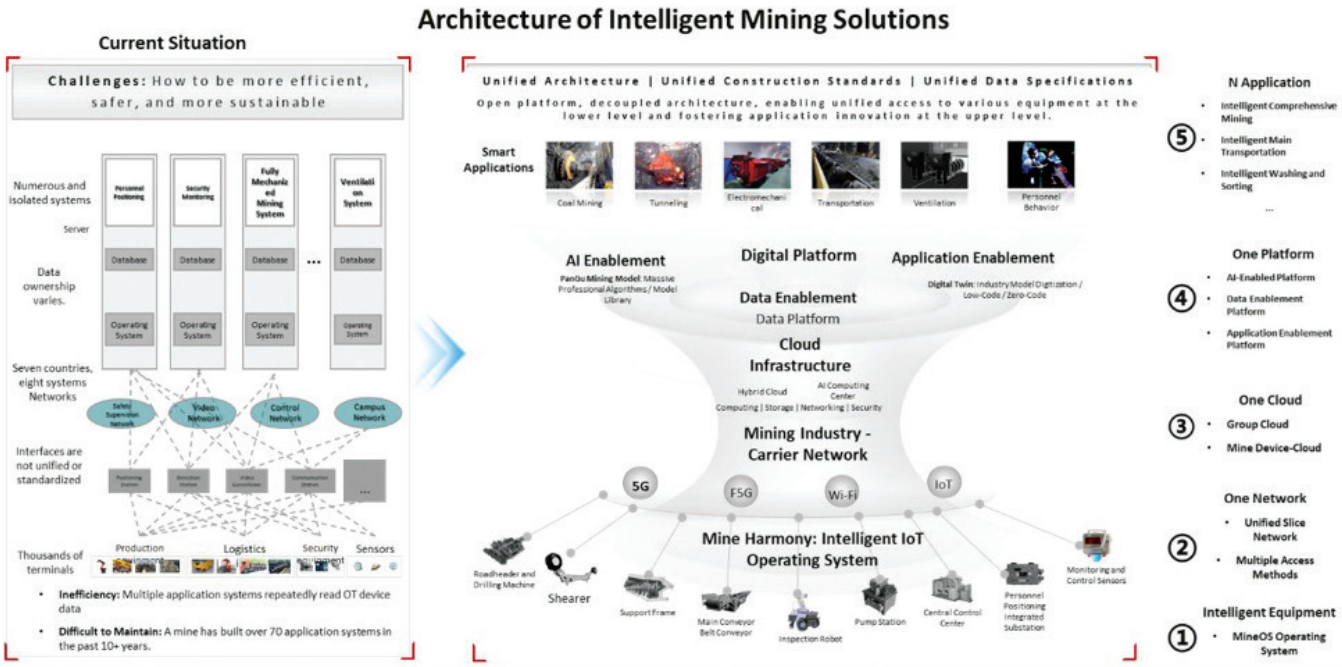

Figure 5: Integrated intelligent mining architecture - "One Network, One Cloud, One Platform, N Applications"

High bandwidth, low latency communication technologies including 5G, Industrial Wi-Fi, Industrial IoT, and cloud-based communication networks build on this sensing capability. These technologies can be used to transmit data seamlessly and in real time throughout the entire mining industry, providing reliable communication between field equipment, centralised control centres, intelligent platforms, and operational management systems. This connectivity improves the coordination of operations, remote monitoring, and real-time decision-making at geographically distributed mining locations.

At the highest layer, Full Intelligence is powered by the confluence of AI, big data analytics, cloud computing, and predictive modelling technologies. These are intelligent systems which enable the conversion of raw operational data to actionable insights with predictive analytics, dynamic forecasting, autonomous control, and intelligent decision-making.

AI systems can, for instance, forecast equipment failures before machines break down, detect gas concentrations which fall outside of normal ranges, detect early signs of geological instability, and optimise transportation routes and production scheduling in real time.

Therefore, mining safety management shifts from a reactive to a proactive and predictive model of risk prevention. In addition, the integrated digital platforms are a collection of information from various operational and management systems in a single intelligent controlled environment. This integration provides a rich improvement in situational awareness, cross functional collaboration, operational transparency, and data driven, intelligent management of the entire mining value chain.

The integration of Full Perception, Full Connectivity, and Full Intelligence is the technological foundation of autonomous and remote mining operations, helping to create safer, smarter, and more sustainable mining environments.

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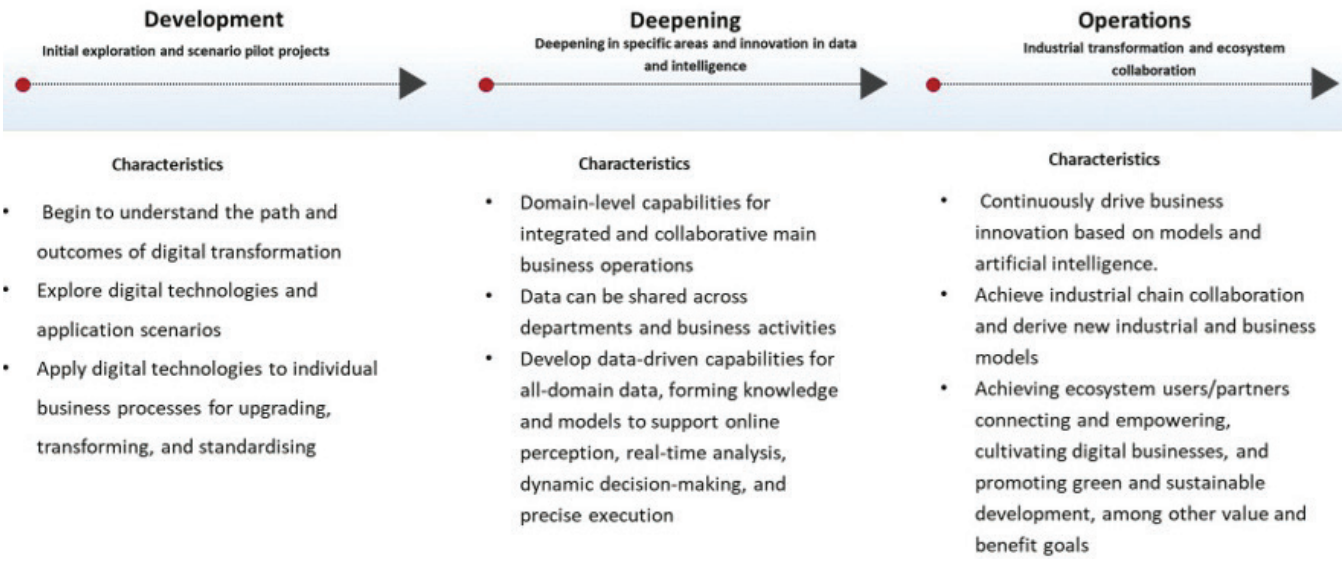

Figure 6: Phased digital transformation journey toward intelligent and ecosystem-driven mining operations

Intelligent Mining Ecosystem & Operational Integration

The rapid advancement of autonomous and intelligent mining technologies is fundamentally transforming operations across the global mining industry. Modern, smart mining environments increasingly integrate autonomous haulage systems, intelligent monitoring platforms, remote controlled mining equipment, AI powered production optimisation systems, predictive hazard detection technologies, and intelligent ventilation systems into a unified operational ecosystem. These technologies enable mining companies to improve operational safety, productivity, sustainability, and resource utilisation while significantly reducing human exposure to hazardous working environments.

The effectiveness of intelligent mining operations depends heavily on integrated digital architecture capable of supporting large-scale, real-time, and data-driven operational management. Traditional mining systems are often fragmented, characterised by isolated operational networks, incompatible platforms, inconsistent data standards, and disconnected monitoring systems, all of which create operational inefficiencies and coordination challenges.

In contrast, intelligent mining ecosystems integrate production equipment, sensors, monitoring systems, cloud infrastructure, AI platforms, and industrial applications into a centralised and interconnected operational framework.

Within this integrated ecosystem, autonomous operational technologies allow mining vehicles and equipment to operate continuously with minimal human intervention, thereby reducing downtime, increasing productivity, and minimising risks associated with human fatigue and operational error. Remote operational systems further strengthen safety by enabling operators to monitor and control underground and high-risk mining activities from centralised control centres located away from hazardous environments.

At the same time, intelligent monitoring systems continuously assess equipment performance, conveyor systems, ventilation conditions, environment indicators, and production activities in real time. Through the integration of AI, predictive analytics, cloud computing, and real-time data processing, mining companies can identify operational anomalies, anticipate potential hazards, optimise production scheduling, and implement corrective actions before risks escalate into critical incidents.

The integrated architecture also supports advanced capabilities such as digital twins, AI-enabled operational platforms, predictive maintenance systems, intelligent industrial parks, and centralised data management platforms. These technologies collectively enhance situational awareness, strengthen cross functional coordination, improve operational transparency, and support more intelligent and data driven decision making across the mining value chain.

Ultimately, the convergence of autonomous operations, integrated digital infrastructure, AI, and centralised operational management is redefining mining operations from labour-intensive and reactive systems into fully connected, intelligent, and proactive mining ecosystems. The transformation not only improves operational efficiency and production continuity but also enables mining companies to achieve safer, smarter, and more sustainable operations in high-risk mining environments.

Future of Mining: Fully Intelligent Operations

The path of Full Intelligence in mining is steadily making progress and machines are becoming active agents which are increasingly able to sense their surroundings, make proactive decisions, make more informed predictions on operational conditions, and seamlessly interact with human and digital systems.

Today, mining companies are using more sophisticated technologies increasingly, including AI, cloud computing, industrial IoT, big data analytics, digital twins, and high-speed communication networks. These technologies are transforming the industry by improving safety, facilitating smart and autonomous mining, and contributing to the long-term sustainability of the industry.

Figure 6 shows the long-term phases and evolutionary path of digital transformation in the mining industry. Mining organisations usually go through various developmental phases which start with early digital exploration and scenario-based pilot projects. These early efforts slowly evolve into more effective operational integration with the help of shared data platforms, smarter analytics, and AI-driven decision support tools.

Ultimately, the change is not limited to the organisation. It will also cascade into an ecosystem level, with various digital platforms, cloud-based infrastructures, smart industrial networks, and collaborative business systems, creating a new end-to-end intelligent mining ecosystem.

As this transformation evolves and develops, future intelligent mines will increasingly depend on fully integrated systems which can optimise operations in real time, predict maintenance issues, coordinate operations autonomously, and prevent hazards proactively. Intelligent systems will continually process streams of operational, environmental, and safety-related data to support dynamic decision-making, resource allocation optimisation, energy optimisation, and environmental sustainability.

In addition, the integration of AI, cloud, 5G, IoT and digital twin technologies will drive the development of highly adaptive and self-optimising ecosystems in mines. These technological synergies will drive mining companies to change from reactive and labour-intensive operating models to predictive, autonomous, and data-driven operating models.

The transition to fully intelligent mining ecosystems will not only boost productivity and resilience but it will also set the benchmark for the industry in terms of safety, sustainability, and competitiveness in high-risk mining environments.

Conclusion

This new trend in autonomous and remote mining operations is changing the definition of safety and management in hazardous mining settings. By leveraging AI, Industrial IoT, cloud platforms, predictive analytics, and autonomous operating systems, mining companies can drastically cut exposure of humans to hazardous environments while boosting operational efficiency, sustainability, and decision making at the same time. But this transformation is not limited to technology implementation. Achieving sustainable success depends on organising and consolidating digital infrastructure, implementing consistent data systems, securing government backing, organisational change, and ongoing efforts to nurture digital talent.

Future mining competitiveness will be based on the combination of advanced technology and human capability transformation as mining companies continue to adopt intelligent operations. In conclusion, autonomous and remote mining is not just about technology; it's about a shift in strategy that puts safety, intelligence, sustainability, and operational excellence at the forefront of mining in the future. ■

Note: This article was developed based on a presentation delivered during the Talent Development Workshop on Sustainable Development in Sarawak's Mining & Quarrying Industry, organised by CENTEX on 10 December 2025.



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Drone Photogrammetry & AI Assisted Quarry Assessment

by:



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USM professor, professional engineer specialising in geotechnical engineering, rock engineering, underground construction, subsurface characterisation, and advanced geological modelling.



Ir. Prof. Dr. Mohd Hazizan Mohd Hashim

USM academic, professional engineer and researcher specialising in geotechnical, mining and blasting engineering.

Quarry conditions change rapidly. Blasting creates new rock faces, excavators reshape broken rock, and stockpile volumes change as material is moved around the site. As a result, engineers regularly need to know how much rock is available, what the blast has produced, and which areas require closer inspection.

Drone photogrammetry helps answer these questions by converting overlapping aerial photographs into a three-dimensional model that can be measured, compared, and analysed. At Universiti Sains Malaysia, we have applied drone imagery for stockpile volume measurement and quarry-face mapping.

Figure 1 shows the data collection and processing workflow. The following examples demonstrate how automated image analysis can assist with stockpile delineation, blast evaluation, discontinuity mapping, and weathering classification. These methods are useful decision-support tools which improve the efficiency of measurement and inspection. However, they should not be considered reliable predictors of slope instability or rock block failure.

From Photographs to Measurable Quarry Models

For many quarry faces and stockpiles, photogrammetry provides an efficient alternative to airborne laser scanning. Matching features in overlapping photographs can reconstruct three-dimensional surfaces from which clouds, digital elevation models, orthophotos, and textured surface models can be generated (Figure 1). Integrated geological mapping software further enables measurement of discontinuity orientations, bench geometry, and surface characteristics. Consequently, a single survey dataset can support multiple applications, including stockpile volumetric estimation and slope modelling. However, reliable results depend on appropriate image acquisition, survey control, processing workflows, and trained personnel. Ground-based imagery may complement UAV surveys, whereas laser scanning remains preferable in areas with poor texture, restricted access, or stringent accuracy requirements.

Getting the Survey Right in the Field

Stockpiles and steep quarry faces require different imaging strategies. Nadir photographs efficiently capture quarry floors, whereas high walls require oblique images acquired from multiple directions and elevations. Detailed mapping of fractures and rock fragments often demands higher-resolution imagery than volumetric assessments.

Accurate scaling and positioning rely on ground-control points or properly implemented RTK/PPK GNSS workflows. Independent checkpoints should validate model accuracy. Before analysis, image quality and reconstruction reliability must be assessed, with attention to blur, shadows, dust, occlusions, and data gaps. A convincing image is not necessarily a reliable measurement.

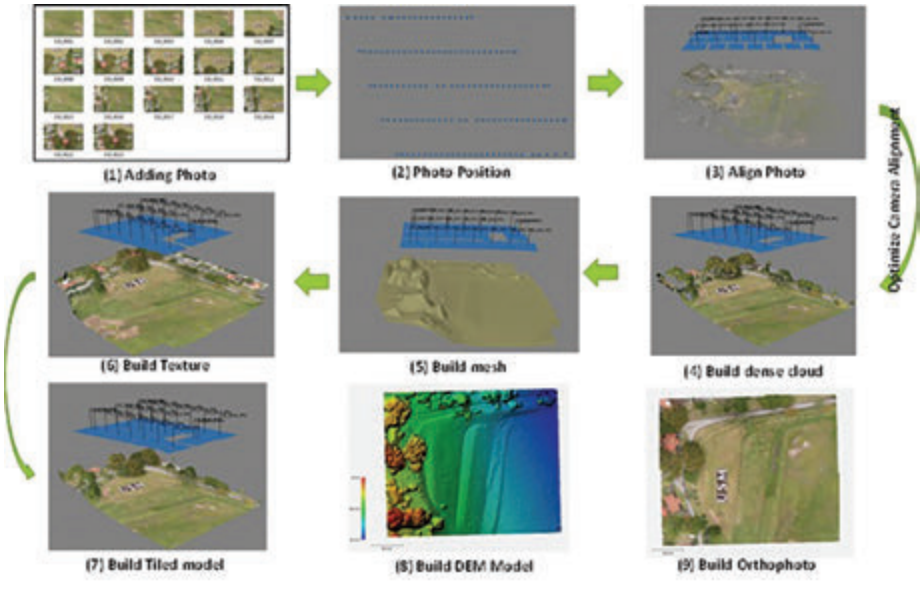

Figure 1: Photogrammetric processing workflow from image import and alignment to dense point cloud, mesh, texture, digital elevation model and orthophoto

Rapid Local Control for Rock Face Surveys

Accurate photogrammetry requires reliable model scaling and orientation. While RTK GNSS and total station surveys remain the preferred methods when absolute coordinates or high-accuracy control are required, repeated ground-control setup around newly exposed quarry faces can be time-consuming.

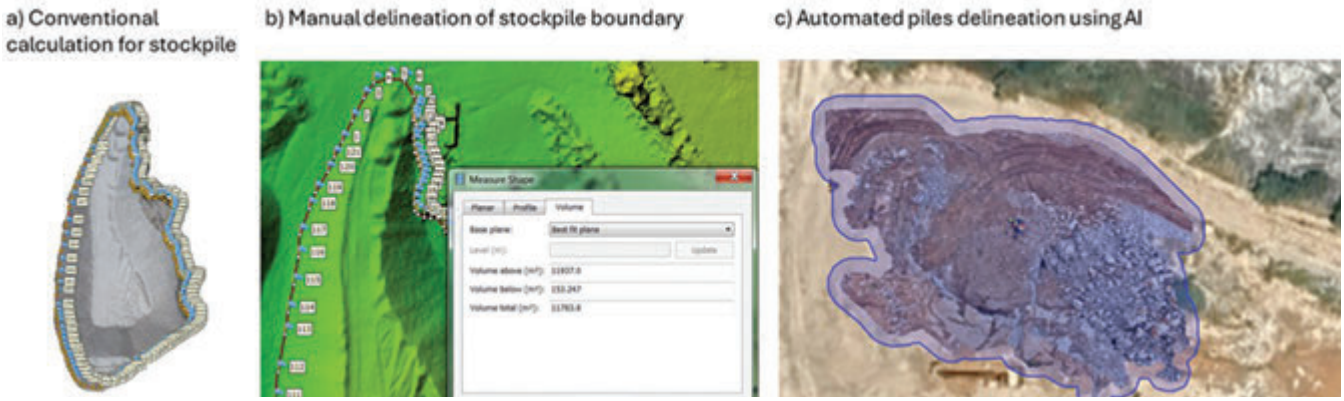

Figure 2: Stockpile volume workflow: (a) point-by-point boundary definition, (b) manual delineation and volume calculation on the reconstructed surface, and (c) AI-assisted delineation from UAV imagery

To improve efficiency, our team developed a portable referencing tool that established a local east-north-up coordinate system using three coded targets, measured arm lengths and a compass bearing. The coded targets provide scale and orientation during photogrammetric processing. In field applications, setup and coordinate preparation require less than five minutes, compared with approximately 45-60 minutes for conventional ground-control procedures. This comparison relates only to setup efficiency and not equivalent global-coordinate accuracy. Compass-based orientation requires magnetic declination correction and checks for local interference. Conventional survey control remains necessary for contractual surveys, local-coordinate requirements, and long-term monitoring. USM filed a Malaysian patent application (PI2026005262) for the apparatus and method in 2026.

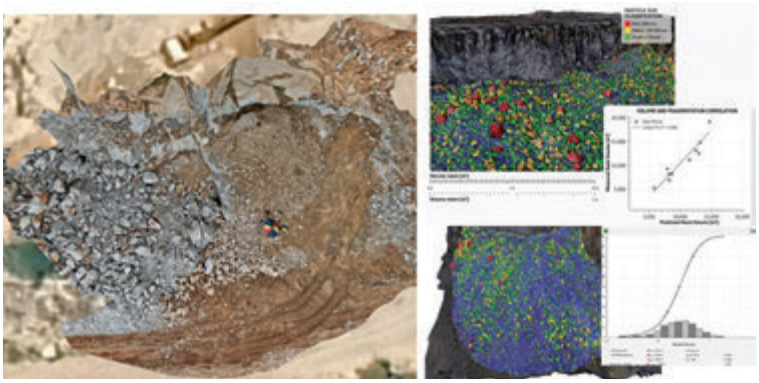

Figure 3: Photogrammetric analysis of a quarry muckpile, showing 3D reconstruction, surface particle-size distribution and a comparison of predicted muck volume with measured bank volume. Source: adapted from 3GSM FragMetriX

AI Assisted Stockpile Measurement

Conventional stockpile volume estimation requires manual delineation of pile boundaries and definition of a reference base surface before calculation. See Figures 2(a) and 2(b). Although effective for individual stockpiles, the process becomes inefficient when multiple piles require repeated measurement.

To improve productivity, AI-assisted workflows can segment stockpiles from surrounding ground surfaces and propose boundaries using orthophotos or reconstructed three-dimensional models. See Figure 2(c).

Operators must subsequently review and refine these boundaries before volume computation. While AI streamlines delineation, accurate results still depend on reliable base-surface definition, appropriate survey scaling, complete surface coverage, and consistent human verification throughout measurements.

From Blast Volume to Fragmentation

The loose muckpile volume differs from the in-situ rock volume before blasting. Meaningful comparisons require consideration of pre-blast surfaces, fragmented material, and the reference surface used for measurement. UAV-derived models can capture bench, face, blast-hole and muckpile geometries, enabling comparisons between pre-blast, post-blast, and post-mucking conditions. Although automated segmentation can assist delineation, engineering review remains essential where irregular pile toes, material accumulation, or concealed floor surfaces affect accuracy.

The same photogrammetric dataset can support fragmentation assessment. Figure 3 integrates image-based particle identification and size classification with a reconstructed muckpile surface to estimate surface particle-size distribution. Comparisons between predicted muck volume and measured bank volume can assist blast evaluation, loading operations, and crusher-feed planning.

However, these outputs should not be regarded as direct measurements of the entire fragment population. Estimates may be influenced by fines, partially obscured fragments, image scale, and segmentation performance. Consequently, site-specific validation against established sampling or measurement methods is essential before results are adopted as performance indicators.

Screening Quarry Faces for Potentially Unstable Blocks

Once a quarry model has been generated, it can support preliminary identification of blocks with potential detachment hazards. Intersecting discontinuities may form blocks susceptible to sliding, toppling, or rockfall.

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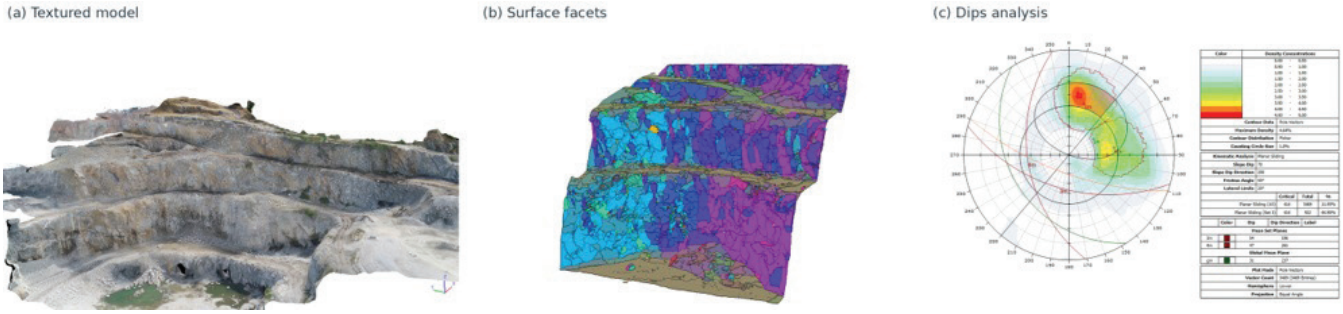

Figure 4: Integrated quarry-face analysis: (a) textured photogrammetric model, (b) extracted surface facets, and (c) stereographic analysis in Dips. Facet colours identify surface regions, not failure probability

Close-range photogrammetry enables detailed mapping of exposed surfaces while reducing the need for personnel to work directly beneath unstable faces. Automated image-analysis models can assist by highlighting candidate cracks and discontinuity traces, while three-dimensional geometry provides additional information on overhangs, partially detached blocks, and joint intersections. The resulting output should be regarded as a location-based inspection aid rather than a prediction of failure.

Where a credible release block has been defined, trajectory analysis using tools such as RocFall3 may be undertaken to evaluate possible rockfall paths and impact zones. However, results depend largely on the assumed release conditions and surface-interaction parameters. Engineering judgement remains essential because shadows, blast-induced fractures, and weathering features may be misclassified as structural discontinuities. Assessment should also consider discontinuity orientation, persistence, infilling, weathering, groundwater conditions, and intact rock bridges.

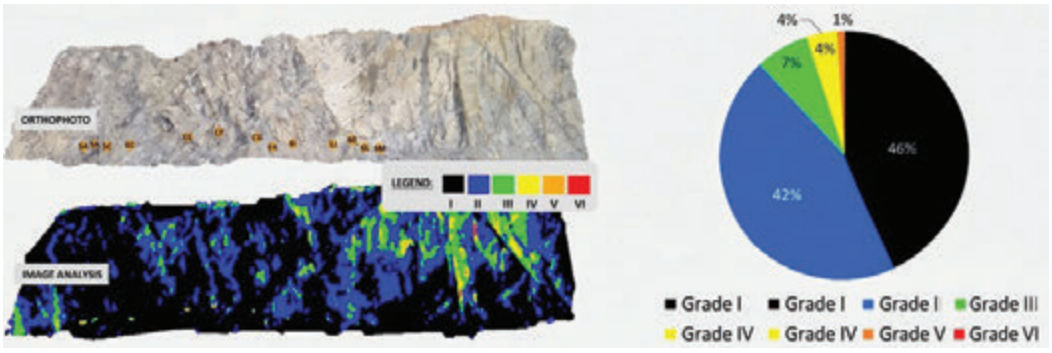

*Figure 5: CIE L*a*b* classification of a quarry face, showing the orthophoto, spatial weathering-grade classes and the proportion of each class*

Areas with insufficient image coverage should remain unassessed rather than assumed stable. Before implementation, automated detection models should be validated against independently reviewed datasets, with performance evaluated through both missed detections and false alarms under varying site and lighting conditions.

Automated surface extraction and machine learning serve different purposes. CloudCompare's FACETS plugin and ShapeMetriX can extract planar surfaces and measure their orientation, but that geometric processing is not, by itself, AI. In Figure 4, the colours identify extracted facets rather than failure probability. Dips can then screen whether the measured joint sets and local face orientation permit planar sliding, wedge sliding or toppling under stated assumptions. This kinematic check narrows the investigation; it does not calculate a factor of safety or predict when movement will occur.

For discontinuity-controlled failure mechanisms, three-dimensional block models can integrate slope geometry, mapped discontinuities, and material-property assumptions. Software such as RocSlope3 evaluates whether modelled blocks are kinematically removable and assesses stability under specified joint strength, groundwater pressure, loading, and support conditions.

When geological observations define a credible and bounded block, its volume may also contribute to rockfall hazard assessment. However, location and consequence are as important as block geometry. A block above an active haul road presents greater operational risk than one above an unoccupied catch bench. Automated detection can identify potential features, but geological interpretation remains essential for defining realistic blocks. Stability analyses must then be interpreted within site-specific exposure and uncertainty conditions.

Overall slope failure requires different analyses from individual-block assessments. Slide3 applies three-dimensional limit-equilibrium methods to evaluate potential slip surfaces and determine factors of safety, whereas RS3 examines stress distribution and deformation using finite-element analysis. Model selection should reflect the anticipated failure mechanism and available ground data rather than model complexity alone.

Effective risk management requires documentation of location, evidence, uncertainty, probable failure mechanisms, and recommended actions. Depending on assessment outcomes, responses may include detailed inspection, controlled scaling, drainage improvement, ground support, or monitoring.

Mapping Weathering with CIE Colour Analysis

Block geometry represents only one aspect of quarry-face condition. Surface colour can also assist weathering assessment when image acquisition and field classification are rigorously controlled. The CIE Lab* colour space separates lightness (L*) from red-green (a*) and yellow-blue (b*) components, enabling quantitative colour analysis. Thresholds derived from field-verified weathering classes can be applied to orthophotos to map the distribution and proportion of weathering grades across exposed rock faces. See Figure 5.

However, colour remains an indirect indicator of weathering and may be influenced by illumination, shadow, moisture, dust, camera characteristics, and freshly exposed surfaces. Consequently, classification results should complement, rather than replace, engineering geological field mapping and professional interpretation.

Turning Models into Site Decisions

Drone photogrammetry is most effective when applied as a complete measurement workflow rather than as a tool for producing attractive models. Survey design and control establish geometric accuracy, while processing converts images into repeatable surface models. Automated analysis can assist in locating and quantifying features that require engineering verification.

For quarry operations, this workflow improves the efficiency of stockpile inventories, blast assessment, and data collection from steep rock faces. Its value depends on traceability through retained imagery, survey control, checkpoints, processing parameters, uncertainty estimates, and review records. Such documentation supports informed engineering judgement and decision-making. ■



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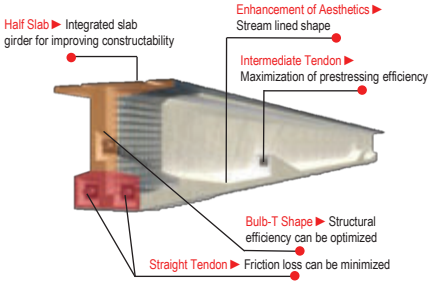

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Towards Holistic Fire Safety Compliance: Media Session with Dato' Sri Nor Hisham Mohammad

by:



Ir. Loo Chee Kin

Chairman, Fire Advisory Board (FAB) and member in seminar organising committee.

IEM and Malaysian Fire Protection Association (MFPA), with the support of Fire & Rescue Department, held a one-day seminar on 1 September 2026. Officiated by the Director General of Fire & Rescue Department of Malaysia, Dato' Sri Nor Hisham Mohammad, it was attended by 400 engineers and industry practitioners in the fire safety field. The seminar was on the new Regulations introduced in 2026 under the Fire Service Act 2025 Act A1764 to allow fire industry stakeholders to understand the Regulation implementation details and timelines. Ir. Kim Kek Seong of the IEM media team took the opportunity to hold an interview session with Dato' Sri Nor Hisham. Present were IEM President Ir. Yau Chau Fong and MFPA President Mr. Tee Siew Chong.

Q: What is the timeline for Bomba to enforce the new Regulations and will there be a transition period for industry players to adapt and make the necessary improvements?

Dato' Sri Nor Hisham: First, we need to understand that the amendment to the Fire Services Act 1988 (Amendment 2025) involves 7 major areas covering various aspects of fire safety regulation in the country. This includes matters within our direct control, such as the management and regulation of volunteer fire brigades and the fire service welfare fund.

Secondly, we are also enforcing the registration of fire safety consultants and fire safety engineers as well as the registration of "competent persons" regarding the 28 key products we regulate – products utilised in fire safety installations.

For the first time, we are also introducing regulations for Fire Safety Managers (FSM) and Fire Safety Officers (FSO) where we will be mandating the specific appointment of these personnel to oversee systems in buildings which require a Fire Certificate (FC). There are approximately 9,000 buildings in Malaysia that hold an FC.

Finally, we are enforcing the requirement for private fire brigades at large-scale premises, such as those in Pengerang and Gebeng. We need to establish regulations and standards for these requirements. Then there is the question of who should provide training for these individuals. We have amended the Act to introduce regulations that allow us to appoint and oversee training providers. On top of that, we have regulations governing the establishment of fire cadet units and accredited laboratories for testing fire safety equipment.

The amendment to the Act provides a major one-year transition period for drafting subsidiary regulations — specifically from March 1, 2025, to March 1, 2026. The period from 2026 to 2027 is designated for the transition of regulatory enforcement.



Dato' Sri Nor Hisham Mohammad, Director General of JBPM, delivering his keynote address at the seminar

Some regulations are straightforward, such as those for Fire Safety Engineers and Consultants because the numbers involved are small. The Fire Welfare Fund scheme is also proceeding quickly. However, the process for training providers will take longer because we want to ensure the number of appointed providers will be healthy business competition. So far, we have appointed 13 and a second batch will be appointed to meet the demand for FSM and FSO training. In the future, we will be looking into carbon dioxide system installations. At present, everyone claims to be an expert, so we need to implement regulatory oversight.

We have 414 buildings exceeding 150m in height. Evacuation from a height of 150m or more can be quite challenging. Our current by-laws do not mandate dedicated transfer floors, unlike the IBC standards, which require them at specific intervals. However, the system does allow for transfer to lower levels, provided there is a trained and certified lift operator.

The general transition period for the enforcement of these regulations will be until March 2027.



Group photo with participants, speakers and organisers of the Seminar Towards Holistic Compliance held on 1 September 2026 in Kuala Lumpur

Q: What are the challenges in implementing the complete programme within this one-year period?

Dato' Sri Nor Hisham: For a start, we want to avoid imposing an undue burden on the industry. We do not want the industry to be negatively impacted by training costs or the time staff members will spend in attending courses.

Practicality in the field comes next. Some companies may hold seven Fire Certificates. So, does this necessitate seven FSM and 21 FSO? The Change Management Committee is reviewing this to ensure a practical approach.

Third is career qualification and enhancement. There is collaboration with the Department of Skills Development (JPK), training, and CPD points. These will qualify an individual for assessment leading to SKM (Malaysian Skills Certificate) Level 3, Level 4, and higher certifications.



Guest of Honour Dato' Sri Nor Hisham Mohammad with the Organising Committee. From left: Ir. Dr. Wong Chee Fui (SESIG Chairman), Ir. Dr. Hee Choi (Organising Chairman), Ir. Yau Chau Fong (IEM President), Dato' Sri Nor Hisham Mohammad (Guest of Honour), Mr. Tee Siew Chong (MFPA President), and Ir. Loo Chee Kin (Organising Committee)

Q: What are the roles of the Fire Safety Organisation (OKK) and appointing a Fire Safety Manager and Fire Safety Officer?

Dato' Sri Nor Hisham: The requirements for establishing an OKK and appointing FSM and FSO have actually been in place under the Fire Services (Fire Certificate) (Amendment) Regulations 2020.

Therefore, 2027 is not the year for OKK, FSM, and FSO to be introduced but rather, it is an important period to ensure more comprehensive compliance. Owners of premises and the management are expected to ensure their OKK is properly established and functional (including the appointment of certified FSMs and FSOs), as well as having the relevant fire safety plans and reports.

What we want is for OKK to go beyond documentation and function as a first responder within the premises. FSMs and FSOs must be competent and capable of taking early action to protect occupants while waiting for the Fire & Rescue Department to arrive.

Q: Will there be new talent opportunities for the role of FSM, and what kind of training or career path is available for someone in FSM?

Dato' Sri Nor Hisham: We see strong potential for the FSM to develop into a specialised career in fire safety management. This can create a more structured career ecosystem, particularly in sectors such as hospitals, hotels, offices, factories, shopping centres, places of assembly, and other designated premises.

In terms of professional development, the pathway will involve training, assessment, and accreditation as prescribed by JBPM. FSMs need to be more than just title holders. They must have the knowledge and competency to manage fire risks, oversee fire safety systems, ensure emergency preparedness, and support compliance at their premises. This is also in line with the concept of self-regulation, where premises must have the capability to identify risks, take early action, and ensure their fire safety systems remain operational.

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IEM President Ir. Yau Chau Fong, presenting a token of appreciation to Dato' Sri Nor Hisham Mohammad, Director General of JBPM

Q: Will there be a transition period for existing fire contractor firms to meet the requirements of the Regulations? Will there be a pathway for technicians and engineers in fire contractor firms to upskill themselves?

Dato' Sri Nor Hisham: Yes. A reasonable transition period is provided from February 2026 to December 2026 to allow existing fire contractor firms to adapt their operations, fulfil registration requirements and enhance the competency of their personnel.

For technicians and engineers already working in the industry, there will be an upskilling pathway involving training, relevant work experience and compliance with the prescribed criteria to obtain recognition as a Competent Person (CP). The intention is not to disregard existing experience but to strengthen it with clearer competency requirements and standards.

Q: What will be the entry requirements for a new company intending to become a fire contractor?

Dato' Sri Nor Hisham: A new company intending to undertake fire safety works will need to fulfil registration requirements and criteria prescribed under the Regulations. This includes having recognised competent personnel, the necessary technical capabilities, and meeting the relevant organisational and operational requirements. The key principle is that a company should not be simply registered as a contractor. It must have the capability and competency to carry out fire safety works safely, professionally, and responsibly.

We are not trying to make it difficult for new players to enter the industry. What we want is to ensure that anyone entrusted with fire safety responsibilities has the competency to carry out that responsibility.

Q: What are the benefits for owners of premises under these new Regulations?

Dato' Sri Nor Hisham: The biggest benefit will be a higher level of fire safety and greater confidence among premises owners that their fire safety systems are properly managed.

With the registration of Competent Persons, Fire Safety Contractors, Fire Safety Consultants, and Fire Safety Organisations, responsibilities become clearer and fire safety management will no longer depend entirely on inspections by JBPM. For designated premises, the establishment of an OKK comprising FSMs and FSOs also strengthens the concept of self-managed fire safety.



MFPA President Mr. Tee Siew Chong presenting an appreciation plaque to Dato' Sri Nor Hisham Mohammad, Director General of JBPM

There are three key benefits: Prevention, preparedness and accountability. Risks can be identified earlier while premises management and occupants will have a clearer structure for response during an emergency, and there will be competent individuals with clearly defined responsibilities for fire safety.

Ultimately, we want to move from a mindset of "waiting for Bomba to arrive" to one where the occupants of the premises are capable of identifying risks and taking early action before Bomba arrives.

Q: Is there any projected cost difference if a premises owner engages or uses Firefighting Equipment and Fire Safety Installations Certified Person for Fire Safety Installation (CPFSI)?

Dato' Sri Nor Hisham: Certified Person for Fire Safety Installation (CPFSI) is a registered individual responsible for registering fire safety equipment and installations (KMK/PKK) for product approval through the e-Premis system. The CPFSI is not involved in the maintenance of KMK/PKK within buildings.

However, if the premises owner is referring to a Competent Person for Fire Safety Contractor (CPFSC), they may engage a registered Fire Safety Contractor (FSC) firm. The premises owner does not engage the CPFSC directly. At present, there is no projected difference in cost as this will depend on the type and design of the KMK/PKK systems and these may vary.

Q: How will Fire Safety Consultants be able to improve fire safety for the public and the community going forward?

Dato' Sri Nor Hisham: Fire Safety Consultants are not new. They have long worked with JBPM, particularly in areas such as fire safety engineering, risk assessment, and fire safety design. What has changed is that their role will now be more structured and regulated under the Fire Services Act 1988 [Act 341] and the Fire Services (Fire Safety Consultant and Fire Safety Consultant Firm) Regulations 2026.

Their expertise helps to ensure fire safety designs and systems are appropriate to the actual level of risk, particularly for complex developments or facilities with specialised hazards. For the public and the community, the benefit is that fire safety can be addressed much earlier at the design and development stage rather than when an emergency actually occurs. With competent and regulated consultants, we can strengthen the country's fire safety ecosystem in a more professional, effective, and comprehensive manner.

Q: Is the timeframe the same and are there staffing constraints on the part of the Fire & Rescue Department?

Dato' Sri Nor Hisham: Digital systems such as e-Premis have helped greatly to streamline the registration process and ease the workload of staff members. Previous enforcement measures were largely administrative, such as suspending or revoking certificates without severe penalties. With these amendments, legal action and fines can now be imposed.

An "Open Door" approach: The Department is always open to getting industry feedback and resolving issues transparently.

Enforcement will be carried out nationwide, not just in Kuala Lumpur or Putrajaya. Close collaboration with industry associations, such as IEM, MFPA, etc., ensures that Malaysian products and contractors meet international standards and quality.

Conclusion

The organising committee would like to extend a big thank you to Dato' Sri Nor Hisham, the speakers, moderators, and sponsors for making the event a success and to the IEM Excom, executives, and volunteers from the Mechanical Engineering Technical Division (METD), Safety In Engineering Special Interest Group (SESIG), and Fire Advisory Board (FAB). ■





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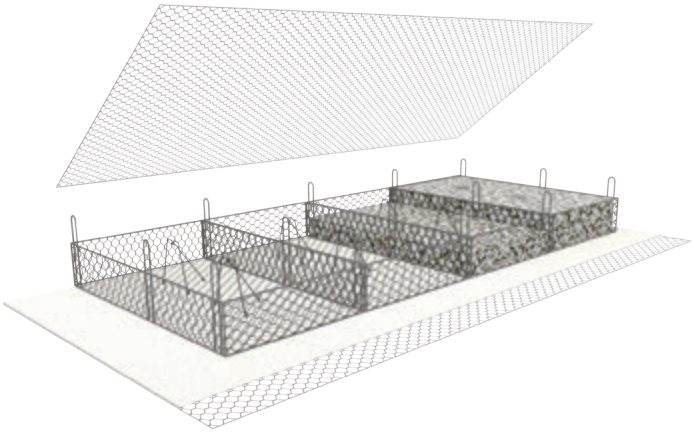

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Technical Visit to Rahman Hydraulic Tin Sdn. Bhd.



by:
Ms. Anati Aqilah Abdul Rahman

The Institution of Engineers, Malaysia (IEM), through Oil, Gas and Mining Technical Division (OGMTD), organised a technical visit to Rahman Hydraulic Tin Sdn. Bhd. (RHT). The visit offered engineers and industry participants a valuable opportunity to observe one of Malaysia's most established tin mining operations and to appreciate the engineering considerations supporting responsible mineral development.

Established in 1907 and located in North Perak, RHT has developed into the longest operating open-pit tin mine in the region. As a subsidiary of Malaysia Smelting Corporation (MSC), the company remains a significant contributor to the nation's tin-in-concentrate production and continues to support local economic activity through direct employment and contractor engagement. This reflects the continued socio-economic importance of the mining sector.



IEM members, Industry representatives and RHT personnel during the site visit



Top view of the RHT Mine



Water treatment

First, the participants were briefed on RHT's approach to balancing operational efficiency with environmental stewardship. A key focus was the management of Acid Mine Drainage (AMD) which may occur when sulphide minerals such as pyrite are exposed to oxygen and water. The briefing demonstrated how engineering controls, environmental monitoring, and progressive rehabilitation are applied to minimise environmental impacts and protect surrounding waterways.

Among the practices highlighted were the encapsulation of potentially acid-forming materials, erosion and sediment control measures, river rehabilitation works, and active water treatment using hydrated lime. Participants were also introduced to RHT's passive water treatment research, including aerobic and anaerobic systems, phytoremediation, and Successive Alkalinity Producing Systems (SAPS). These initiatives reflected the value of integrating scientific research, field experience and engineering judgement in addressing complex environmental challenges.

The visit further emphasised the importance of systematic water quality monitoring, routine sampling, and laboratory analysis in ensuring regulatory compliance and operational assurance. In addition, RHT's initiatives in air quality management, scheduled waste handling, slope stabilisation, and mine rehabilitation demonstrated the multidisciplinary nature of modern mine management.

Beyond technical and environmental aspects, participants gained further insight into RHT's contribution to community development, workforce training, safety performance, and good governance. The company's recognition at the 4th ASEAN Mineral Award 2025 for Best Practices in Metallic Minerals Mining also illustrated its commitment to sustainable operations and responsible corporate conduct.

The technical visit delivered meaningful professional exposure for IEM members and other participants by connecting classroom and industry knowledge with practical site implementation. It enhanced the participants' understanding of sustainable mining practices, strengthened awareness of environmental responsibility, and highlighted the important role of engineers in supporting safe, compliant, and future-ready industrial operations.

In addition, the visit strengthened professional appreciation of sustainable mining by demonstrating how engineering practice supports environmental protection, regulatory compliance, and responsible industry development. ■

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Jazan Port & Terminal Capital Planning: Lessons Learnt



by:
Ir. Azizul Azuan Sahrum



Jazan Port is one of largest ports in Saudi Arabia (Source: Portsmagazine website)

On 11 July 2026, IEM's Oil, Gas & Mining Technical Division (OGMTD) organised a physical technical talk titled Jazan Port & Terminal Capital Planning – Lessons Learnt. The talk was delivered by Mr. Riyad H. Al Sulaiman, a Facilities Planning Consultant with Saudi Aramco. He has over 28 years of experience in planning, operations, project management, terminal development, and maritime logistics. He was also involved in several major projects exceeding US$5 billion, including the Jazan and Jafurah developments.

Participants gained practical insights into the planning and development of Jazan Economic City Port in Saudi Arabia and its integration with the Jazan Refinery. The Jazan Economic City was conceived as a catalyst for industrial and social development, with the 440,000 barrel-per-day Jazan Refinery serving as a major anchor tenant. The refinery and port were developed as integrated elements of the wider economic ecosystem; the port provided essential infrastructure for the movement of crude oil, liquid products, sulphur, containers and other bulk commodities.

The aim of the talk was to provide engineers, planners, and project management personnel with practical insights into the technical and economic considerations involved in planning a major port and terminal development. Rather than focusing solely on engineering design, the presentation highlighted the importance of understanding the business strategy, operational requirements, technical basis, economics, and long-term development needs when making major capital investment decisions.

A major message from the presentation was that capital planning should be driven by overall business strategy rather than developing individual facilities in isolation. The port business model considered different potential activities, including liquid berths, general cargo, bulk solids, container operations, and iron ore movements, demonstrating the importance of understanding the geographical market and long-term business objectives before establishing the infrastructure strategy.



Aerial view of Jazan Port (Source: https://www.bayut.sa/blog/en/explore-saudi/jazan-port/)

The presentation also highlighted the importance of establishing an appropriate design basis and capacity requirements. Vessel sizing, berth spacing, channel dimensions, and port infrastructure must be evaluated against operational requirements, applicable standards, and future business needs.

For example, Jazan Port was designed to accommodate liquid bulk carriers of up to 120,000 DWT, while the outer port zone could accommodate larger crude tankers. The container facilities were designed to accommodate vessels of up to 15,000 TEU, allowing the port to serve more than

99% of the global fleet. These decisions demonstrated that vessel selection, draft limitations, and future market requirements must be considered together when establishing port infrastructure requirements.

Another important lesson was the need to make fact-based and evidence-based engineering decisions. The discussion on channel width demonstrated this clearly. Although the existing 260m channel exceeded several recognised design guidelines, additional analysis was undertaken, including computer-based Fast Time Simulation and Real Time Simulation with pilots. The final decision to widen the channel to 350m reflected not only technical calculations but also consideration of the competency and reliability of third-party pilots.

The session further demonstrated that stakeholder alignment and lifecycle considerations were essential. The proposed relocation of sulphur facilities, for example, required consideration of future container operations, supporting yards, fencing, conveyor requirements, operational proximity, and potential impact on future land utilisation.

The technical talk provided participants with practical lessons on the development of a major oil and gas port and terminal. Apart from technical design, the presentation demonstrated that business strategy, engineering analysis, operational requirements, stakeholder considerations, safety, and long-term development objectives need to be integrated when making major capital investment decisions.

The overall lessons derived from the session can be summarised as follows:

- Start with the business strategy before defining the technical solution.
- Establish a clear and realistic planning basis, including vessel sizes, capacity, and future requirements.
- Consider the whole port and terminal ecosystem, rather than individual facilities in isolation.
- Use engineering calculations, simulation, and independent verification to support major capital decisions.
- Evaluate decisions based on technical, economic, operational, and safety considerations.
- Consider future expansion and avoid decisions which create unnecessary constraints or higher lifecycle costs.
- Ensure that different stakeholders are aligned early, particularly developers, operators, port authorities, marine specialists, and project management teams.

The session was particularly relevant to engineers involved in oil and gas terminals, ports, marine infrastructure, facilities planning, project management, and major capital projects. The lessons from the Jazan development are useful references for future mega projects, particularly where complex interfaces exist between industrial facilities, ports, marine operations, and wider economic development.

Overall, the session offered participants practical perspectives on how engineering judgement and evidence-based decision-making can be applied to major capital projects. It also highlighted the importance of considering the long-term consequences of today's planning decisions. ■







IEM Golf Tournament 2026

by:



Ir. Gary Lim Eng Hwa



Ir. Cha Hoong Kum



The Institution of Engineers, Malaysia held the Golf Tournament 2026 on 15 August 2026 at Kelab Rahman Putra, Malaysia Sungai Buloh, Selangor. Through the efforts of the committee members, we secured 19 sponsors and attracted 124 participants which included members and corporate business associates.

A group photograph was taken before the start of the event. Everyone was smiling and ready to tee off. The weather was near perfect, with fluffy clouds in the sky and light breeze throughout. All participants had the chance to do some networking during the game and the lunch that followed.

Event Organising Chairman Ir. Cha Hoong Kum gave a welcome speech. Then Certificates of Appreciation were presented to all the sponsors:

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The tournament was divided into 2 categories – Guest and Member. Winners were picked based on System 36 Stableford points. See diagram below.

The organisers would like to express their sincere gratitude and thanks to all sponsors, participants and Secretariat staff members who had contributed to the success of the event. ■

IEM Member Category			
Champion	Datuk Ir. Mohd Aminuddin Mohd Amin	38 points	Handicap-13
1st Runner Up	Chia SY	37 points	Handicap-9
2nd Runner Up	Ir. Shamil Abu Hassan	37 points	Handicap-11
Guest Category			
Champion	Eric Low	39 points	Handicap-8
1st Runner Up	Khor Hiok Hoong	37 points	Handicap-10
2nd Runner Up	Azam	37 points	Handicap-13



Performer demonstrates the jumping action to reach the suspended centrepieces

Indigenous Engineering Marvel

by:



Ir. Nur Azhani Mohamad Rosli

OGMTD Secretary/Treasurer, with a passion for Reliability & Asset Management, Instrumentation & Control, and Telecommunication Systems in Oil & Gas Industry.

Engineers are naturally curious about how things work. During a visit to the Kadazan Dusun Cultural Association (KDCA) compound in Kota Kinabalu, Sabah, a Lansaran (jumping board structure) caught my attention. Located in the centre of the Murut longhouse, it is used in ritual performances to drive away evil spirits and to celebrate victories during the head-hunting era.

In the past, Murut Tahol warriors would bring home enemy skulls and hang them to dry above the platform. Then they sang and danced around it in a form of worship ritual. The dancers would take turns to jump up to touch the suspended human skull; later, a hornbill beak was used as a substitute.

From an engineering perspective, the Lansaran is a fascinating indigenous design. The platform can be from 8-30 sq ft in size and can accommodate up to 30 dancers simultaneously. The three-layered wooden structure is carefully designed to create a spring-like bouncing effect.

At the base is the Sapunti, containing approximately 40 small wooden sticks called lalahuon; these help absorb and distribute the impact forces. The middle layer uses Rumulus wood and comprises long straight beams of at least 10.6m (35ft) in length to provide structural strength while allowing controlled flexibility. The top layer, the Pinapanan, forms the jumping surface and is secured with rattan bindings.



The 3 layers of the jumping board structure

What makes it remarkable is the careful selection and arrangement of materials. The structure is designed to not only support dynamic loads from the dancers but also to produce resonant sounds during the performance.

In engineering terms, it incorporates principles of structural dynamics, load distribution, engineering material, and vibration control. Without design software or engineering calculations, the Muruts had developed an effective and sustainable structure through observation and experience.

The Lansaran is as a showcase for the ingenuity of Sabah's indigenous people, reminding us that successful engineering is not only about strength and functionality but also about preserving identity, culture, and heritage. ■

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Floating Sphere

The futuristic Fuji Television Building on Odaiba Island, Japan, is a distinctive, eye-catching giant sphere that appears to float between two towers. Suspended between the towers and connected by pedestrian bridges, the sphere is supported by four steel columns. It is made of titanium, a material chosen for its excellent resistance to corrosion caused by the salt-laden air in Tokyo Bay. Located in the seismically active region, the structure incorporates earthquake-resistant structural design to withstand seismic forces. Designed by renowned architect Kenzo Tange, it is an example of how engineering and architecture can work together to create a structure that is both functional and visually striking. This iconic sphere attracts visitors and engineers alike, inspiring admiration for its innovation and bold design vision. ■



Photography by:
Ir. Nur Azhani Mohamad Rosli

Date: 21 October 2026

To all Members,

LIST OF CANDIDATES ELIGIBLE TO SIT FOR THE PROFESSIONAL INTERVIEW FOR THE YEAR 2026

The following is a list of candidates who are eligible to sit for the Professional Interview for the year 2026.

According to the IEM Bylaws, Section 3.8, the names listed below are published as eligible candidates to become Insitution Members, provided that they pass the Professional Interview in 2026.

If there are any Corporate Members who have objections against any candidate deemed unsuitable to sit for the Professional Interview, a letter of objection can be submitted to the Honorary Secretary, IEM. A letter of objection must be submitted within one month from the date of publication.

Ir. Alex Looi Tink Huey
IEM Honorary Secretary

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CIVIL ENGINEERING	
FARHAN SUFYAN BIN BORHAN	BE HONS (UMS) (CIVIL, 2002)
SHAHRILFAHMI BIN ZAKARIA	BE HONS (UTM) (CIVIL, 2006)
ELECTRICAL ENGINEERING	
AMIRA SHAZA BINTI MOHAMED YUNUS	BSC (IUPUI) (ELECTRICAL ENGINEERING, 2019)
NURSYAHIDAH BINTI MOHD NAZIR	BE HONS (UTHM) (ELECTRICAL, 2006)
ELECTRONIC ENGINEERING	
ARNI MUNIRA BINTI MARKOM	BE HONS (UTeM) (ELECTRONICS ENGINEERING-COMPUTER ENGINEERING, 2007) MSc (UKM) (MICROELECTRONICS, 2009) PhD (UM) (ELECTRONIC, 2016)

APPLICATION FOR CORPORATE MEMBER

NAME	QUALIFICATION
CIVIL ENGINEERING	
MARIYANA AIDA AB KADIR	BE (UTM) (CIVIL, 2005) MSc (UNI OF PAVIA, ITALY & UNI OF GRENOBLE, FRANCE) (EARTHQUAKE ENG. & ENG. SEISMOLOGY, 2007) PhD (UNI OF EDINBURGH) (STRUCTURE ENG., 2013)
TAY CHIA HONG	BE HONS (UTM) (CIVIL, 1994)

MEMBER TRANSFER

M'SHIP NO.	NAME	QUALIFICATION
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89008	KUGENDRAN A/L PONNUSAMY	BE HONS (MANIPAL INT. UNI) (CIVIL, 2020) MPM (UTM) (CIVIL ENGINEERING, 2024)
56772	MANISAH BT ABDULLAH	BE HONS (UPM) (CIVIL, 2014)
117102	MOHD AZRIN SAFIQ BIN MD ZAIN	BE HONS (UTM) (CIVIL, 2022) MSc (UiTM) (CONSTRUCTION, 2026)
85125	WOON SIONG SHENG	ME HONS (THE UNI. OF NOTTINGHAM) (CIVIL, 2015)
89518	YAP JIAN YANG	BE HONS (UNI. OF SALFORD) (CIVIL, 2016) ME (UTM) (CIVIL, 2020)
136463	YEO SIANG CHUAN	BE HONS (USM) (CIVIL, 2006) MBA (MMU) (BUSINESS ADMINISTRATION, 2012) PhD (UTM) (2025)
ELECTRICAL ENGINEERING		
76765	MUHAMMAD AFIQ NASRULLAH BIN MUHAMMAD HISHAM	BE HONS (UTHM) (ELECTRICAL, 2018)
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