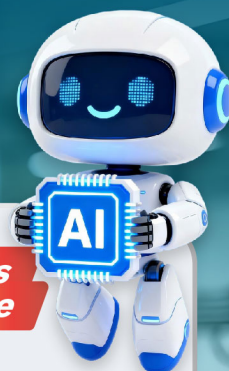




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SMART FACTORY

FORGING THE DIGITAL THREAD IN MODERN MANUFACTURING

In today's world, people often talk about the Industrial Revolution, digitalisation, 3D printing, artificial intelligence(AI), and smart technologies. These developments have had a profound impact on the manufacturing sector. Factories are no longer just places where products are made. They are becoming intelligent systems that can think, connect, and improve themselves. To understand how we reached this stage, we need to revisit history. **CONTINUED ON PAGE 02 >>**

By Ts. Siti Afifa binti Anuar, MAHSA University

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/chief editor's note

Industry 4.0 sparked widespread concerns that automation and artificial intelligence (AI) would replace human workers. While some routine tasks have indeed been automated, the emergence of Industry 5.0 highlights a different reality: technology performs best when it complements, rather than replaces, human intelligence.

In the manufacturing sector, AI excels at processing data, recognising patterns, and supporting decision-making. However, it still depends on human judgement, creativity, ethical reasoning, and accountability. As a result, human responsibilities are shifting towards higher-value roles that require creativity, critical thinking, and complex problem-solving skills.

AI is also transforming the manufacturing sector through applications such as predictive maintenance, quality

control, and Environmental, Social and Governance (ESG) reporting. Although adopting AI in these areas can improve efficiency and enhance transparency, organisations must carefully evaluate whether the tangible and intangible benefits justify the required investment.

These developments raise important questions. Will organisations require fewer but more highly skilled employees? Can Industry 5.0 reduce unemployment, and contribute to higher incomes, or will it simply redefine the skills needed to remain employable?

Unfortunately, we do not have sufficient time to answer these questions in depth. Nevertheless, one thing is certain. We must embrace current technologies to ensure that our manufacturing sector remains competitive and keeps pace with global developments. 

Assoc. Prof. Dr. Mohamad Asmudzam Ahamat

CONTINUED FROM PAGE 01 >>

The Evolution of Industry: From Steam Engines to Human-Machine Collaboration

The story of industrial development is not just about machines and factories. It includes how human civilisation continuously improves the way we produce goods, solve problems, and live our daily lives. From the 1760s until today, the world has experienced several major industrial revolutions that transformed the manufacturing sector, phase by phase. These changes have led us from manual labour to intelligent systems that can think, connect, and learn[1].

Industry 1.0, Industry 2.0 and Industry 3.0

The First Industrial Revolution (Industry 1.0) began in the 1760s when machines powered by steam replaced much of the manual labour. Before this, products such as textiles were made by hand, which slowed production. Inventions like the Spinning Jenny and Power Loom increased textile production, while steam engines improved mining by allowing access to deeper coal reserves. This period showed that machines could work faster and more efficiently than human labour alone.



Industry 4.0 represents one of the most exciting stages of industrial evolution. It is often referred to as the era of smart manufacturing; machines, systems, and people are all connected through digital networks. At the heart of this revolution is the Internet of Things (IoT).

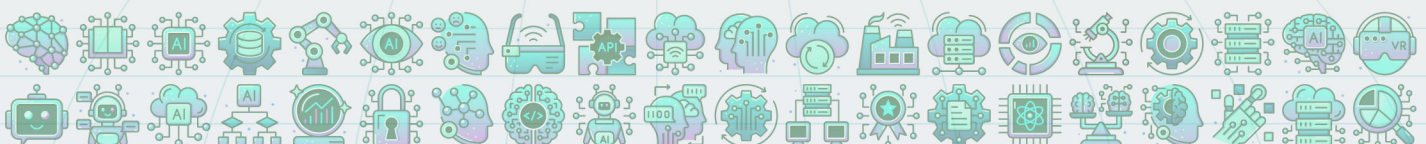
The Second Industrial Revolution (Industry 2.0) started in the 1870s and was driven by electricity and mass production. Factories became more efficient as they no longer relied only on steam power. A major innovation was Henry Ford's assembly line, where workers performed specific tasks as products moved along a production line. This method greatly increased productivity and reduced

manufacturing costs, making products such as the Ford Model T affordable.

The Third Industrial Revolution (Industry 3.0) began in the 1970s with the introduction of computers, electronics, and automation in manufacturing. Technologies such as Programmable Logic Controllers (PLCs), Computer-Aided Design (CAD), Computer Numerical Control (CNC) machines, and industrial robots helped automate production processes. These technologies improved accuracy, efficiency, and safety while reducing human error. Industry 3.0 marked the transition from mechanical systems to digital automation.

Industry 4.0

Industry 4.0 represents one of the most exciting stages of industrial evolution. It is often referred to as the era of smart manufacturing; machines, systems, and people are all connected through digital networks. At the heart of this revolution is the Internet of Things (IoT). The IoT can be described as "Internet of Everything" because almost every machine, sensor, and device can now be connected and communicate in real time.





Unlike Industry 4.0 which focuses on automation and connectivity, Industry 5.0 brings humans back to the center of manufacturing systems. Industry 5.0 focuses on collaboration between humans and machines rather than the complete replacement of human workers.

Cyber-physical systems combine physical machines with digital control systems, allowing machines to be monitored and controlled through computer-based platforms. Big data analytics is used to process and analyse large amounts of data collected from machines and production systems to support better decision-making. Cloud computing allows data to be stored and accessed remotely, making it easier for companies to manage and share information across different locations. Artificial intelligence enables machines and systems to learn from data, identify patterns, and make intelligent decisions.

In smart factories, machines are no longer separate or isolated units. Instead, they are fully connected and continuously communicate with each other by sharing data. This connectivity allows factories to operate in real time and make faster, more accurate decisions, leading to more intelligent and efficient production systems. For example, sensors installed in machines continuously monitor performance indicators such as temperature, vibration, and speed, and immediately send this data to monitoring systems. AI then analyses this information to detect patterns and predict possible machine failures before they happen. As a result, maintenance can be carried out in advance, preventing unexpected breakdowns and reducing downtime. In addition, production lines can automatically adjust their operations to improve efficiency,

reduce waste, and ensure smooth workflow. This concept is known as predictive and intelligent manufacturing. Today, factories also use autonomous robots, digital dashboards, and remote monitoring systems, allowing managers to control operations from anywhere in the world.

Industry 5.0

Unlike Industry 4.0 which focuses on automation and connectivity, Industry 5.0 brings humans back to the center of manufacturing systems. Industry 5.0 focuses on collaboration between humans and machines rather than the complete replacement of human workers. In this approach, artificial intelligence works together with human intelligence to improve creativity, increase productivity, and support better decision-making in complex situations.

One of the key features of Industry 5.0 is human-machine collaboration, where humans and intelligent machines work side by side, combining human creativity with machine precision and speed. Another important feature is AI supporting human decision-making, where artificial intelligence analyses data and provides recommendations, while humans make the final and more strategic decisions.

Industry 5.0 also emphasises mass customisation of products, meaning that products can be designed and produced according to individual customer needs instead of mass-producing identical items for everyone. In addition, it strongly promotes sustainable and eco-friendly

production systems, where industries focus on reducing waste, saving energy, and minimising environmental impact while still maintaining productivity and efficiency.

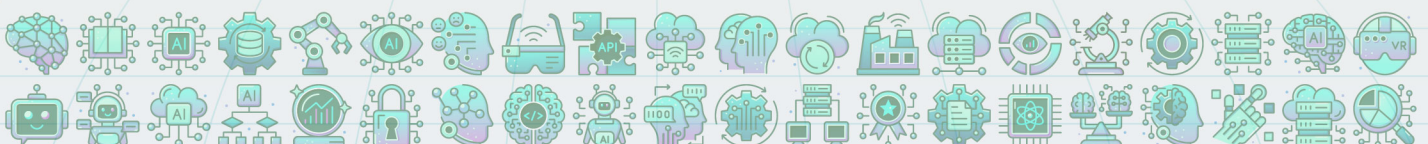
In Industry 5.0, machines handle repetitive and technical tasks, while humans focus on creativity, innovation, and strategic thinking. This creates a more balanced and sustainable manufacturing ecosystem.

The Four Levels of Smart Factory Evolution

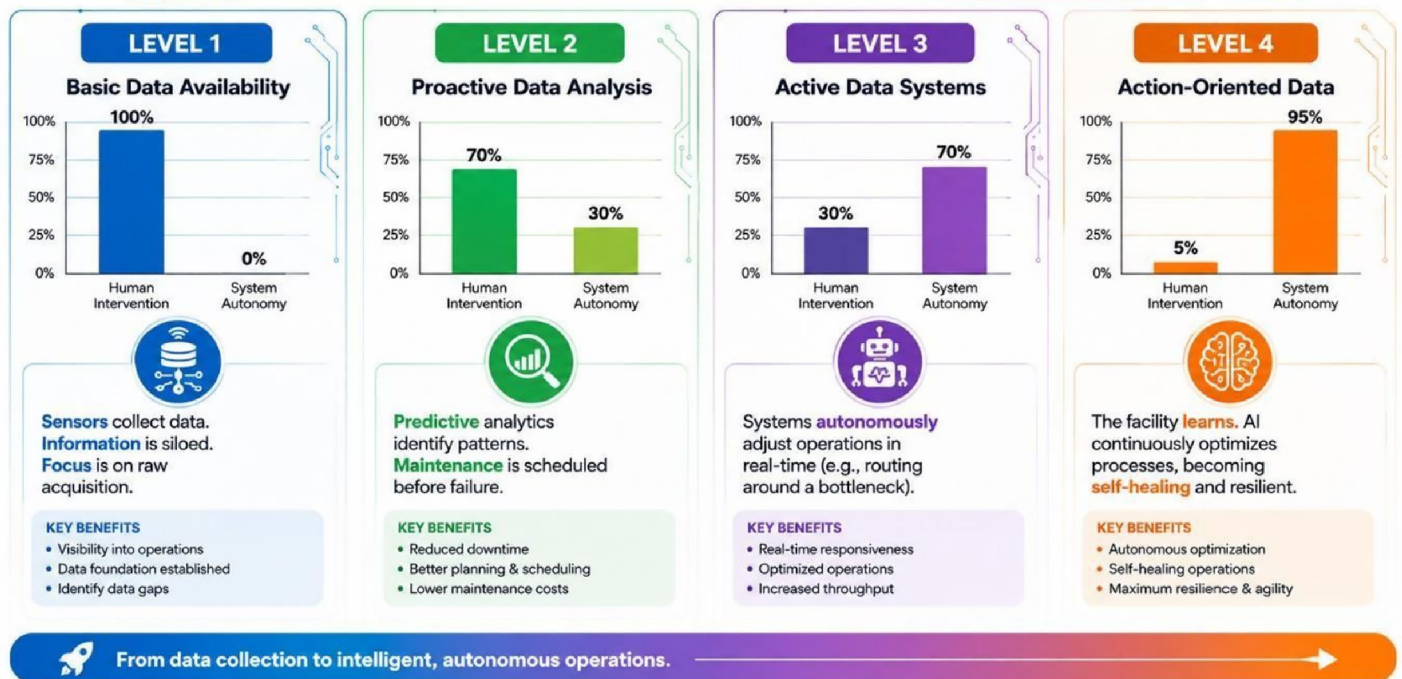
Smart factories do not appear instantly; instead, they develop gradually through different levels of digital maturity. To better understand this transformation, the smart factory evolution can be divided into four main levels, starting from basic data collection and progressing toward fully intelligent and self-optimising systems.

For the Basic Data Availability level, factories mainly focus on collecting raw data from machines using sensors. These sensors capture important information such as temperature, speed, and machine performance. However, at this stage, the data is not yet connected or analysed in depth. It is often stored in separate systems, also known as siloed data. The main focus at this level is simply data collection without advanced interpretation or decision-making.

The second level is Proactive Data Analysis. At this stage, data begins to play a more active role in decision-making. Around 70% of decisions are still made by humans, and the remaining 30% are supported by digital systems. The collected data is analysed using basic predictive tools to identify patterns and detect potential problems before they occur. This allows companies to plan maintenance activities, reducing the risk of unexpected machine failures and improving overall efficiency.



The 4 Levels of Smart Factory Evolution



Four Levels of Smart Factory Evolution. Adapted and summarised by the author using Google Notebook [2].

The third level is Active Data Systems, where automation becomes more advanced. In this stage, machines and systems are capable of making real-time adjustments based on incoming data. The balance of decision-making also shifts, with approximately 70% of actions being carried out by systems and only 30% requiring human intervention. This level focuses on real-time automation, where production processes are continuously monitored and automatically optimised to maintain efficiency and quality.

The highest stage is the Action-Oriented intelligent factory, where the factory operates almost as a fully intelligent system. At this level, artificial intelligence continuously learns from data, improves processes, and optimises production without constant human control. The factory becomes self-learning and even self-healing,

meaning it can detect issues, correct them, and improve performance automatically. Human involvement is reduced to around 5%, mainly for supervision and strategic decision-making. The main focus of this level is to achieve a fully intelligent, adaptive, and highly efficient manufacturing system.

Conclusion

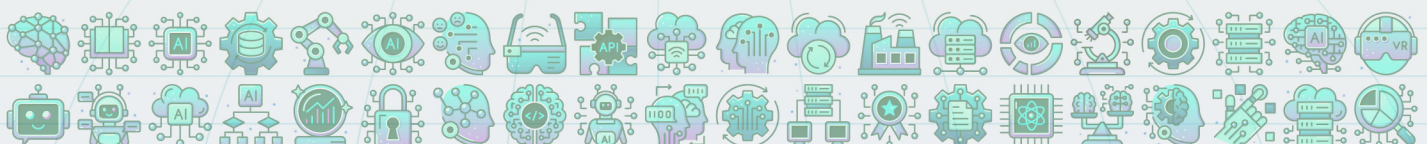
The journey from Industry 1.0 to Industry 5.0 shows evolution in manufacturing, from simple hand tools to intelligent, connected systems. However, achieving a true smart factory is not just about technology. It requires clear goals, planning, and implementation. It cannot remain just an idea written on paper or discussed in meetings.

Industry players must invest in real systems, train their workforce, and embrace change. They also need to be

resilient and continuously adapt to emerging technology trends in smart factory development. Because in the end, the future of manufacturing is not just smart machines; it is a smart ecosystem where humans and technology work together to build better, faster, and more sustainable production systems.

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SMART FACTORIES: How AI Is Transforming Manufacturing

Automating Scope 1 and Scope 2 ESG Data Collection and Reporting

The Convergence of Industry 4.0 and Sustainability

The manufacturing sector is undergoing a profound dual transformation driven by the simultaneous rise of digitalisation and sustainable development. Historically, industrial success was measured almost exclusively by throughput, yield, and cost efficiency. However, modern global dynamics have introduced a critical new metric: Environmental, Social, and Governance (ESG) performance. As regulatory frameworks tighten and consumer preferences shift toward eco-friendly products, manufacturers face intense pressure to monitor and reduce their ecological footprints. At the heart of this transformation is the smart factory, an interconnected industrial ecosystem powered by the Internet of Things (IoT), cloud computing, edge computing, and artificial intelligence (AI). These technologies enable manufacturers to monitor operations in real time, optimise production processes, and improve environmental performance. Collectively referred to as Industry 4.0, these digital technologies provide manufacturers with unprecedented visibility into production processes, enabling data-driven decision-making and continuous operational improvement. By embedding intelligent software into production processes, companies are discovering that the very same tools used to maximise productivity can also be leveraged to achieve ambitious sustainability targets. This article explores how AI transforms

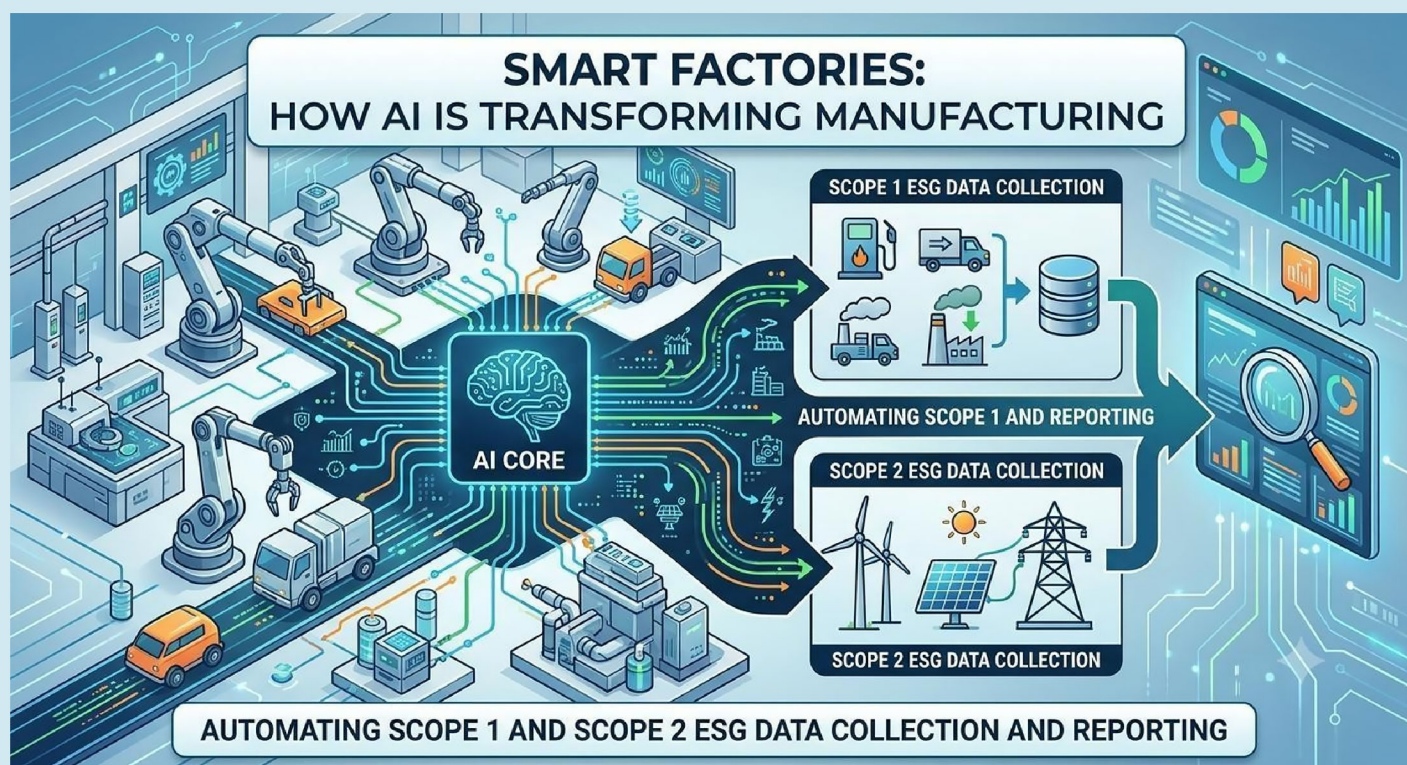
manufacturing from a major carbon emitter into a highly optimised, data-driven system capable of automating compliance, tracking carbon emissions in real-time, and dramatically streamlining the complex workflows associated with Scope 1 and Scope 2 ESG reporting.

Understanding the ESG Core: Deciphering Scope 1 and Scope 2 Emissions

To fully appreciate the role of artificial intelligence in corporate sustainability, one must first understand the fundamental distinction between Scope 1 and Scope 2 emissions, as defined by the Greenhouse Gas (GHG) Protocol.

Scope 1 emissions represent direct greenhouse gas discharges that occur from sources owned or controlled by the manufacturing entity. In a factory environment, this includes the combustion of natural gas in industrial boilers, chemical processes in melting furnaces, and fuel consumed by corporate logistics fleets. Because these emissions happen directly on-site, they are highly dependent on operational variables and fuel quality.

Conversely, Scope 2 emissions encompass indirect greenhouse gas emissions associated with the generation of purchased energy. This primarily involves electricity, steam,



heating, or cooling consumed by the plant but produced off-site by external utility companies. While a manufacturer does not directly burn the fuel to generate electricity, their operational demand directly drives those utility emissions. Accurately tracking both scopes requires a comprehensive accounting framework capable of capturing direct fuel consumption as well as utility grid consumption, a task that has traditionally been notoriously difficult, error-prone, and slow due to siloed data architectures.

QUICK DEFINITION

Scope 1 covers direct emissions from owned sources (e.g., boilers, furnaces). Scope 2 covers indirect emissions from purchased electricity, steam, and heating used during production.

The Traditional Challenges of Manual ESG Data Collection

For decades, the standard approach to environmental reporting in the manufacturing industry relied heavily on retrospective, manual data collection processes. At the end of a quarter or fiscal year, sustainability teams would manually compile physical utility bills, request fuel logs from facility managers, and extract raw operational hours from isolated legacy machinery. This fragmented methodology is plagued by significant vulnerabilities, including human data-entry errors, lost documentation, and inconsistent units of measurement across different plant locations. Furthermore, traditional reporting methods only provide a historical look-back. By the time an annual ESG report is generated, the data is months old, rendering it entirely useless for proactive operational adjustments. Factory managers cannot alter energy-intensive behaviors that occurred half a year ago; they can only react to past inefficiencies. This lack of granularity also compromises auditability. When external auditors

attempt to verify a corporate sustainability claim, tracing an aggregated emissions figure back to a specific machine or shift becomes an administrative nightmare, creating significant compliance risks and leaving companies vulnerable to damaging accusations of greenwashing.

How AI Powers Intelligent Real-Time Data Collection?

Smart factories overcome these historical reporting bottlenecks by replacing manual workflows with continuous, automated data pipelines orchestrated by artificial intelligence. Through the deployment of IoT smart meters, thermal sensors, and edge-computing devices across the production floor, every piece of machinery becomes an active data generator. AI algorithms process these massive streams of high-frequency data, instantly categorising energy usage patterns and linking them directly to specific production lines or product batches. Instead of waiting for monthly utility statements, AI engines interact directly with building management systems and digital sub-meters to track kilowatt-hour consumption minute by minute.

For direct Scope 1 emissions, AI systems monitor fuel flow rates in furnaces and combustion efficiency in real-time. This continuous ingestion of operational data ensures that nothing is overlooked, forming a highly reliable digital ledger of environmental metrics. By transforming raw, unorganised electrical and chemical signals into structured, context-rich carbon data, AI establishes a single source of truth that bridges the gap between floor operations and corporate sustainability offices.

Transforming Scope 1: AI-Driven Operational Optimisation

In the context of Scope 1 emissions, artificial intelligence acts as a powerful optimisation engine that targets the root causes of direct fossil fuel combustion. Industrial equipment like boilers, kilns, and chemical reactors frequently operate at sub-optimal levels due to fluctuating ambient

temperatures, variations in raw material composition, and slight mechanical wear. AI models, specifically machine learning algorithms trained on historical process data, can predict the exact fuel-to-air ratios required to maintain peak thermal efficiency. By continuously analysing live sensor data, the AI can make micro-adjustments to burner controls, reducing unnecessary fuel consumption and minimising the resulting greenhouse gas emissions. Additionally, AI-driven predictive maintenance algorithms identify when a machine is deteriorating or running inefficiently before a breakdown occurs. A friction-heavy conveyor belt or a misaligned hydraulic pump draws significantly more energy and generates more heat, inflating the plant's direct footprint. By flagging these anomalies early, AI ensures the facility operates at maximum thermal and mechanical efficiency, preventing localised spikes in direct emissions.

Optimising Scope 2: Intelligent Management of Purchased Energy

Managing Scope 2 emissions requires a sophisticated understanding of how energy consumption interacts with external utility grids, and this is where AI excels. The carbon intensity of electrical grids fluctuates constantly throughout the day depending on the mix of power sources available, such as solar, wind, coal, or natural gas. AI systems in smart factories integrate seamlessly with live regional grid data to track these dynamic emission factors. Armed with this knowledge, AI can execute 'load shifting' strategies, scheduling highly energy-intensive manufacturing processes such as heavy metal stamping or large-scale cooling cycles to occur during periods when the grid is supplied by a higher percentage of renewable energy. For factories equipped with on-site microgrids, solar arrays, or battery energy storage systems, AI acts as an intelligent dispatcher. It calculates real-time trade-offs between consuming stored green energy, drawing power from the main grid, or throttling non-essential operations. This intelligent demand-side management substantially lowers the

total indirect carbon footprint of the facility while simultaneously reducing overall energy expenditures.

The Structural Architecture of AI-Driven ESG Reporting

To better comprehend how these technologies fit together, it is helpful to visualise the architecture of an automated ESG data pipeline. The process operates as a multi-tier hierarchy. At the foundational layer sits the Physical Layer, consisting of equipment, gas flow meters, and IoT smart meters. Above this is the Data Ingestion Layer, where Edge Devices and Gateway Routers aggregate raw signals. The third level is the AI Analytics Core, where Machine Learning Models apply carbon emission factors, execute anomaly detection, and perform predictive optimisation. Finally, the top layer is the Reporting Interface, delivering automated dashboards for compliance and audit-ready data. This structured workflow ensures that raw data flows smoothly from the factory floor directly into finalised corporate reports. By embedding intelligence at every level of the infrastructure, manufacturers can completely eliminate manual intervention, dramatically reducing the risk of data corruption while ensuring that every metric reported can be traced back to its precise physical origin.



One of the most compelling advantages of implementing artificial intelligence in smart factories is the creation of an unassailable, audit-ready trail of environmental data. In an era where regulatory authorities, such as the SEC in the United States and the CSRD in Europe, are mandating third-party assurance for climate disclosures, the validity of data is paramount.

Achieving Audit-Ready Compliance and Eliminating Greenwashing

One of the most compelling advantages of implementing artificial intelligence in smart factories is the creation of an unassailable, audit-ready trail of environmental data. In an era where regulatory authorities, such as the SEC in the United States and the CSRD in Europe, are mandating third-party assurance for climate disclosures, the validity of data is paramount. AI-driven compliance software automatically maps ingested consumption metrics against standard international carbon emission databases, including those from the IPCC and EPA. This eliminates the risk of using outdated or incorrect conversion factors. Because every data point is timestamped, localised, and signed digitally from the machine level, external auditors can verify the integrity of the data from the initial sensor

reading down to the final number on the balance sheet. This absolute transparency completely eliminates the systemic risk of greenwashing, providing stakeholders, corporate boards, institutional investors, and regulatory bodies with total confidence that the manufacturer's reported Scope 1 and Scope 2 targets are precise, verifiable, and reflective of true environmental performance.

The Strategic Value of AI in Sustainable Manufacturing

Ultimately, the integration of artificial intelligence within smart factories fundamentally changes the relationship between industrial manufacturing and environmental sustainability. AI effectively dissolves the historical conflict between maximising operational profitability and minimising carbon footprints. By automating the highly complex, tedious processes of Scope 1 and Scope 2 data collection, AI releases corporate sustainability teams from manual administrative burdens, allowing them to focus entirely on high-impact strategic reduction initiatives. Moreover, the real-time operational optimisations delivered by machine learning cut energy waste, lower direct fuel costs, and significantly improve manufacturing margins. As global carbon reporting standards evolve from voluntary frameworks into strict legal mandates, utilising AI-driven ESG systems will no longer be an optional luxury for progressive enterprises. It will become an indispensable operational necessity, distinguishing market leaders from laggards, and paving the way toward a highly transparent, fully optimised, and genuinely sustainable industrial future.

Reporting Interface	Generates audit-ready ESG dashboards, compliance sheets, and carbon disclosure documents.
AI Analytics Core	Processes data streams, applies dynamic GHG emission factors, and predicts optimisation vectors.
Data Ingestion Layer	IoT Gateways and edge nodes aggregate high-frequency signals, handling unit conversion and filtering.
Physical Floor Layer	Smart meters, thermal sensors, fuel gauges, and production machinery capture raw parameters.



FROM “MADE IN MALAYSIA” TO “MADE BY MALAYSIA”: Building Technology for the World

An interview with
**Dato' Ts. Dr. Shanmuganathan
Palanisamy**

Founder and CEO of ECTrons Sdn. Bhd.

Could you briefly introduce yourself and share your professional journey that led to the establishment of ECTrons Sdn. Bhd.?

I have spent more than 36 years in the electronics, embedded computing, and industrial automation industry, working with multinational technology companies in engineering and executive leadership. Throughout my career, I had the privilege of leading teams that delivered advanced computing solutions for global industrial and mission-critical applications.

While the experience was invaluable, I increasingly felt that Malaysia possessed tremendous engineering talent but lacked sufficient homegrown technology companies developing our own intellectual property (IP). Too often, we excelled in manufacturing products designed elsewhere, and we tend to be in the phase of “Made in Malaysia” but not so much into “Made by Malaysia”.

That conviction inspired me to establish ECTrons Sdn. Bhd. on my 60th birthday, with the help of an angel investor who genuinely believed in and trusted to fund this establishment. Without his commitment and investments, it would be an impossible mission. ECTrons was founded with a clear purpose to develop Malaysian-designed embedded computing, Edge AI and industrial-related technologies that help industries digitalise while strengthening our nation's technological sovereignty. My vision is simple: to create world-class technology that is Made by Malaysia, Built for the World.

What inspired you to pursue a career in technology and business?

I have always been fascinated by solving real-world problems through engineering from day one.

My transition into entrepreneurship came from a desire to create lasting impact only after my retirement. After great years managing technology developed for established multinational corporations, I wanted to build technologies, intellectual property, and future leaders from Malaysia. Entrepreneurship allows me to turn ideas into products, products into businesses, and businesses into national capabilities.

For me, success is not measured only by commercial performance but by how many engineers I inspire, how many SMEs I help transform, and how much value I create for our country.

What has been the biggest challenge you have faced as the founder and CEO, and how did you overcome it?

The greatest challenge has been building a technology company from the ground up in a highly competitive global market while facing an intense talent war, especially in the northern region where ECTrons HQ is based.

Unlike established multinational corporations, a startup must simultaneously build products, attract talent, secure customers, establish credibility, and manage financial sustainability. As CEO, I continue to need to address these challenges by remaining focused on long-term value creation rather than short-term gains.

Another important lesson was recognising that innovation is never a solo effort. Success comes from building a strong ecosystem of partners who share a common vision. Through strategic collaborations, ECTrons has accelerated innovation while contributing to Malaysia's broader technology ecosystem.



In your view, what mindset or cultural shift is most needed for Malaysia to become a globally recognised technology and innovation hub?

Malaysia needs to move from being primarily a technology adopter and manufacturing nation to becoming a technology creator.

This requires three important shifts.

First, we must encourage greater ambition. Our goal should not simply be to participate in global supply chains but to own technologies, develop intellectual property and create globally recognised brands.

Second, we must cultivate a culture that embraces experimentation and accepts failure as part of innovation. Every successful technology company has learned through continuous improvement.

Third, stronger collaboration between government, academia and industry is essential. Innovation ecosystems flourish when research, commercialisation, funding and market access work together.

Most importantly, we should believe that Malaysian companies can compete globally. Confidence is the first step towards innovation leadership.

How do you see the evolution of Malaysia's technology industry over the past decade?

Malaysia has made remarkable progress over the past decade. We have strengthened our semiconductor ecosystem, accelerated digital transformation across industries, and developed a vibrant startup community supported by government initiatives.

Today, Malaysia is recognised as an important global semiconductor manufacturing hub. However, our next stage of growth should focus on increasing local intellectual property, advanced system design, AI solutions and industrial software.

I believe our future competitiveness will depend not only on manufacturing excellence but also on our ability to



design, innovate and commercialise technologies developed by Malaysian companies.

What emerging technologies do you believe will have the greatest impact on the industry in the next five to ten years?

Artificial intelligence will undoubtedly reshape every industry. However, the real transformation will come when AI converges with Edge Computing, Industrial Shopfloor systems, robotics, and autonomous systems.

Manufacturing will become increasingly intelligent, with AI making decisions closer to machines in real time rather than relying solely on cloud computing. This will improve productivity, energy efficiency, and predictive maintenance.

Cybersecurity will also become increasingly critical as industrial systems become more connected. At ECTrains, we believe the future lies in intelligent edge computing platforms that combine embedded computing, industrial automation, and AI into practical solutions for SMEs and manufacturers.

If you could share one key lesson from your entrepreneurial journey, what would it be?

Build something that creates value beyond yourself with passion, confidence, and a never-give-up attitude regardless of your age.

Technology evolves rapidly, markets change, and competition never stops. However, organisations that focus on

solving meaningful problems, developing people, and creating long-term value will always remain relevant.

Entrepreneurship is not a sprint but a marathon that requires resilience, continuous learning, and unwavering integrity. Success rarely happens overnight, but persistence and purpose will eventually overcome obstacles.

Looking ahead, what kind of legacy do you hope ECTrains will leave, not only in the technology industry, but also in shaping Malaysia's innovation ecosystem?

I hope ECTrains will be remembered as one of the companies that demonstrated Malaysian technology can compete confidently on the global stage.

Beyond developing innovative products, I am hoping ECTrains will become a catalyst for Malaysia's innovation ecosystem by supporting SMEs in digital transformation, nurturing future engineers, collaborating with universities, and creating high-value intellectual property that benefits our nation.

If, in the future, more Malaysian entrepreneurs believe they can build globally respected technology companies because ECTrains helped inspire them, that would be our greatest achievement.

Our aspiration is not merely to build a successful company, but to contribute towards building a stronger, more innovative and more technologically sovereign Malaysia for generations to come.



AI-POWERED ROBOTICS AND AUTOMATION: Revolutionising Malaysia's Manufacturing Landscape

Artificial intelligence (AI) is no longer a futuristic concept confined to research laboratories or science fiction. It has become a practical technology that is transforming industries worldwide, with manufacturing leading one of the most significant technological revolutions of our time.

AI-powered robotics and automation are reshaping production environments by enabling machines to learn, analyse data, and support or automate operational decision-making using real-time information. Rather than simply replacing manual labor, these technologies are creating intelligent manufacturing ecosystems where humans and machines work together to achieve greater productivity, precision, and innovation.

For Malaysia, the integration of AI into manufacturing is particularly significant. Manufacturing remains one of Malaysia's key economic pillars, contributing approximately one-quarter of national GDP and accounting for a significant share of exports and skilled employment. Through national initiatives such as the National Artificial Intelligence Roadmap and the New Industrial Master Plan 2030 (NIMP 2030), Malaysia has demonstrated its commitment to accelerating digital transformation and positioning itself as a competitive player in advanced manufacturing. The successful adoption of AI-powered robotics will therefore play an essential role in enhancing industrial resilience while supporting sustainable economic development.

THE RISE OF AI-POWERED ROBOTICS IN MODERN MANUFACTURING

Traditional industrial robots have served manufacturers for decades by performing repetitive tasks such as welding, painting, assembly, packaging, and material handling. While these systems have significantly improved efficiency, they operate using pre-programmed instructions and are not able to adapt independently when production requirements change.

The latest generation of AI-powered robots represents a major technological leap. By integrating machine learning, computer vision, the Industrial Internet of Things (IIoT), and advanced analytics, these intelligent systems can interpret their surroundings, recognise patterns, learn from operational data, and continuously optimise their performance. This enables manufacturing processes to become more flexible, responsive, and efficient.

One of the most notable developments is the growing adoption of collaborative robots, or Cobots. Unlike conventional robots that are isolated behind safety barriers, Cobots are designed to operate safely alongside human workers. Equipped with intelligent sensors and AI algorithms, they can detect human movement, adjust their actions accordingly, and assist employees with repetitive or physically demanding tasks. Rather than replacing workers, Cobots enhance human capabilities by allowing employees to focus on activities requiring creativity, critical thinking, decision-making, and problem-solving.

AI is also transforming quality assurance across manufacturing industries. Conventional quality inspection depends heavily on human observation, making it susceptible to fatigue and inconsistency. AI-powered computer vision systems now inspect thousands of products every hour using high-resolution cameras and deep learning models capable of identifying microscopic defects, dimensional inaccuracies, colour inconsistencies, and assembly errors with exceptional accuracy. Industries such as semiconductor manufacturing, electronics, automotive, pharmaceuticals, and food processing increasingly rely on these technologies to minimise waste,

improve product consistency, and reduce operational costs.

Another important application is predictive maintenance. Unexpected equipment failures can disrupt production schedules, increase repair costs, and affect customer satisfaction. AI addresses this challenge by continuously monitoring machine conditions using sensors that capture vibration, temperature, electrical current, pressure, and acoustic data. Machine learning algorithms analyse these data streams to detect abnormalities and predict potential failures before breakdowns occur. Maintenance can therefore be scheduled proactively, reducing downtime while extending equipment lifespan and improving operational reliability.

The concept of the Smart Factory further demonstrates the transformative power of AI. Within intelligent manufacturing environments, AI integrates with robotics, IIoT devices, cloud computing, enterprise systems, and advanced analytics to optimise production planning, inventory management, energy consumption, and supply chain operations. Instead of reacting to problems after they occur, AI enables manufacturers to anticipate disruptions, optimise workflows automatically, and make data-driven decisions in real time. Such capabilities significantly improve operational agility in today's rapidly changing global marketplace.

PREPARING MALAYSIA FOR AN INTELLIGENT MANUFACTURING FUTURE

Malaysia is well positioned to benefit from AI-powered manufacturing, particularly through its strong presence in the electrical and electronics, semiconductor, medical devices, aerospace, automotive, and food manufacturing sectors. Many multinational manufacturers operating in Malaysia have already adopted AI-driven technologies such as automated visual inspection, autonomous mobile robots, predictive maintenance, and intelligent production scheduling to improve operational



Machine learning algorithms analyse these data streams to detect abnormalities and predict potential failures before breakdowns occur. Maintenance can therefore be scheduled proactively, reducing downtime while extending equipment lifespan and improving operational reliability.

performance and remain globally competitive.

At the same time, small and medium-sized enterprises (SMEs) are gradually embracing digital technologies through cloud-based automation platforms, affordable robotics, and government-supported digitalisation initiatives. These developments demonstrate that AI adoption is no longer limited to large multinational corporations but is becoming increasingly accessible across the manufacturing ecosystem.

Nevertheless, technology alone cannot guarantee successful transformation. One of the most critical success factors is the availability of a skilled workforce capable of working alongside intelligent systems. As AI automates repetitive and routine activities, new opportunities are emerging in robotics engineering, industrial data analytics, AI system integration, cybersecurity, and smart manufacturing management. Consequently, future technologists must possess multidisciplinary competencies that combine engineering knowledge with artificial intelligence, automation, data science, cloud computing, and digital leadership.

Higher education institutions therefore play a crucial role in preparing graduates for this evolving landscape. Universities must continuously update curricula to incorporate AI applications, robotics, digital manufacturing, and Industry 4.0 technologies while strengthening collaboration with industry to ensure graduates acquire relevant practical skills. Equally important is the need for continuous professional development, enabling today's workforce to reskill and upskill as technologies continue to evolve.

Alongside workforce readiness, organisations must also address issues related to cybersecurity, ethical AI, data governance, implementation costs, and system integration. Responsible AI adoption also requires transparency, accountability, robust cybersecurity, and effective data governance to ensure that intelligent systems remain secure, reliable, and beneficial to both businesses and society.

Ultimately, the future of manufacturing is not defined by machines replacing people but by humans and intelligent technologies working together to achieve outcomes that neither could accomplish independently. AI-powered robotics enables manufacturers to become more productive, resilient, and innovative while allowing human workers to contribute their uniquely human strengths in creativity, leadership, and complex decision-making.

As Malaysia accelerates its digital transformation journey, AI-powered robotics and automation will become central to achieving higher industrial productivity, stronger global competitiveness, and sustainable economic growth. For professional technologists, engineers, academics, and industry leaders, the challenge is no longer whether AI should be adopted, but how it can be implemented responsibly and strategically to create long-term value. By embracing intelligent manufacturing today, Malaysia is laying the foundation for a smarter, more innovative, and globally competitive industrial future.

MBOT Experts Network in Technology, Innovation and Cooperative Event 2026 (MBOT ENTICE 2026)

MBOT ENTICE 2026, themed "Breakthrough with Purpose in the Age of AI", was successfully organised on 18 August 2026 at DoubleTree by Hilton Kuala Lumpur.

MBOT ENTICE 2026 brought together technology professionals, industry leaders, academia, and key stakeholders to exchange ideas, celebrate achievements, and strengthen professional collaborations. The event highlighted the importance of purposeful leadership, innovation, and international cooperation in navigating the rapidly evolving technology landscape in the era of AI.

The programme commenced with the MBOT Town Hall Session, led by MBOT President, Prof. Dato' Ts. Ir. Dr. Mohamed Ibrahim Abdul Mutalib. He shared updates on MBOT's direction and way forward, with a particular focus on the internationalisation agenda.

Following the Town Hall Session, Tan Sri Dato' Sri Haji Syed Zainal Abidin Syed Mohamed Tahir (Chairman of DneX) delivered a keynote address entitled "Lead with Purpose, Inspire with Impact". The keynote address was followed by a technology-sharing session presented by Datin Ts. Ir. Nor Ziha Zainol Abidin, Head of Corporate Ventures, Tenaga Nasional Berhad.

The programme continued with a Fireside Chat entitled "Transformational Leadership in the Age of AI", moderated by Mr. Leon Jala (CEO of PEMANDU Group). The panellists were Dr. Jasmine Begum (General Manager, Corporate External & Legal Affairs, Microsoft ASEAN), Mr. Shahril Hamdan (Managing Director, Bullhound Capital), and Ts. Shahril Ridzaudidin Mohd Mokhtar (Head of Technology & Digital, Malaysia Petroleum Management (MPM), PETRONAS).



YB Datuk Chang Lih Kang, Minister of Science, Technology and Innovation, officiated MBOT ENTICE 2026. The opening ceremony featured the launch of STI 100³ and the book Beyond the Odds: The Transformation of Malaysia's Technology Profession. It was followed by a Mutual Recognition Agreement (MRA) Exchange between MBOT and the Institute of Marine Engineering, Science and Technology (IMarEST), United Kingdom. MBOT also exchanged a Memorandum of Understanding (MOU) with the Institution of Engineering Technicians and Technologists Indonesia (ITERATI). These exchanges further strengthened MBOT's international professional collaborations.

MBOT recognised the contributions and achievements of its members in the technology and technical sectors. The award recipients for 2026 were as follows:

- **Anugerah Teknologis Negara 2026:** Dato' Ts. Ir. Dr. Zahari bin Dollah
- **Anugerah Juruteknik Negara 2026:** Kapten Tc. Dr. Baharin bin Baharom
- **MBOT Woman Leadership Award**

2026: Prof. Ir. Ts. Dr. Suraya binti Abdul Rashid

- **Distinguished Honorable Award:** Prof. Emeritus Datuk Ts. Ir. Dr. Siti Hamisah binti Tapsir, FASc.

MBOT also recognised the contributions from organisations through the MBOT Partnership Excellent Awards 2026. The recipients of these awards were:

- **MBOT Partnership Excellent Award (Industry) 2026:** CelcomDigi
- **MBOT Partnership Excellent Award (Education Provider) 2026:** i-CATS University College
- **MBOT Partnership Excellent Award (Government Agency) 2026:** Jabatan Digital Negara
- **MBOT Partnership Excellent Award (Training Provider) 2026:** Dream Catcher Consulting Sdn. Bhd.

The MBOT Technology and Technical Working Group (TTWG) is key to advancing MBOT's position at the forefront of technology. The MBOT TTWG Excellent Award 2026 was awarded to the TTWG Telecommunication and Broadcasting Technology (TB).

/mbot
registration

70,732



Graduate Technologists

16,077



Qualified Technicians

28,950



Professional Technologists

4,249



Certified Technicians

120,008

Total MBOT Registrants
(As of July 2026)