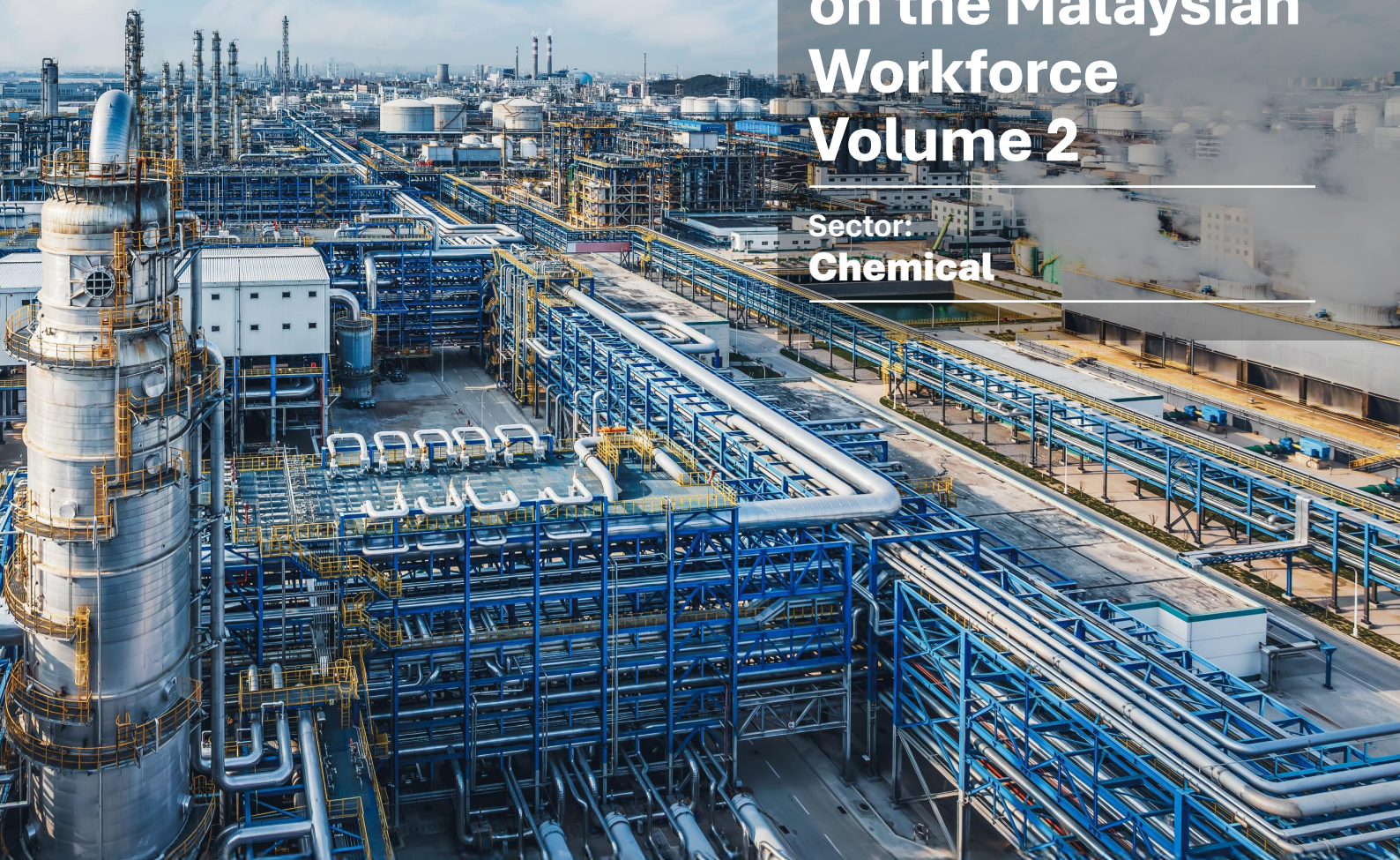
MINISTRY OF HUMAN RESOURCES

TalentCorp
GROUP OF COMPANIES

Impact Study of Artificial Intelligence, Digital, and Green Economy on the Malaysian Workforce Volume 2

Sector:
Chemical



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Preface by the Group Chief Executive Officer of TalentCorp

As Malaysia stands on the threshold of a transformative era, we find ourselves driven by the accelerating forces of Artificial Intelligence (AI), Digital, and Green Economy. These global trends are reshaping industries, redefining the future of work, and challenging us to navigate both the opportunities for job creation and the realities of evolving role redundancies.

With a median age of 31, Malaysia leads a youthful ASEAN region where the median age is just 30. This demographic advantage presents a unique opportunity—a vibrant, dynamic workforce ready to harness the opportunities of a Digital and Green Economy. Yet, it also poses challenges. Youth unemployment and underemployment remain persistent issues across ASEAN, with Malaysia facing a youth unemployment rate of 11% and 36.3% of tertiary-educated employees grappling with skill-related underemployment. These figures demand immediate action. Reskilling and upskilling are not just important—they are imperative as the landscape of jobs continues to evolve.

At TalentCorp, we are honoured to serve as a strategic think tank under the Ministry of Human Resources' (KESUMA) mandate. This critical role allows us to leverage our networks and initiatives, providing data-driven insights that strengthen the government's intelligence capacity and support national policy development, advocacy, and long-term strategic planning.

One of our foremost initiatives in this capacity is the **Impact Study of AI, Digital, and Green Economy on the Malaysian Workforce**. This study is designed to offer key guidance to policymakers and industries, equipping them with the knowledge to prepare the workforce for upcoming shifts. It highlights essential reskilling and upskilling programmes to assist Malaysians affected by job displacement, ensuring they transition smoothly into new roles, fostering sustainable growth, and ensuring no one is left behind.

Through insights gleaned from this study, TalentCorp's MyMAHIR Future Skills Talent Council (FSTC)—an industry-led body dedicated to addressing skills needs—will drive efforts to close critical skills gaps. MyMAHIR's collaboration with industry leaders enables us to identify priority competencies and shape training programmes to meet the evolving demands of their sectors. Aligned with the MADANI Economy framework's focus on lifelong learning and guided by best practices from the International Labour Organization (ILO), TalentCorp will continue working closely with key ministries, agencies, and industry players to develop forward-looking curricula that meet the workforce needs of the future.

As Malaysia navigates this new landscape, the findings from this study will serve as an indispensable resource—providing policymakers, industries, and the workforce with the insights and tools required to stay competitive and resilient in an ever-evolving global economy.

On behalf of TalentCorp, I extend our deepest gratitude to our industry partners, colleagues, and experts for their invaluable contributions to this study. Together, we have crafted a comprehensive and impactful report that will serve as a guide for Malaysia's future of work, ensuring that we are prepared for the challenges and opportunities ahead.

Thomas Mathew
Group Chief Executive Officer
Talent Corporation Malaysia Berhad

“As Malaysia navigates this new landscape, the findings from this study will serve as an indispensable resource— providing policymakers, industries, and the workforce with the insights and tools required to stay competitive and resilient in an ever-evolving global economy.”

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Executive Summary

The global Chemical sector is an evolving sector, valued at USD5.1 trillion (RM22.16 trillion) in 2023, and is projected to expand to USD7.8 trillion (RM33.9 trillion) by 2028, reflecting a compound annual growth rate (CAGR) of 8.7%.[1] This impressive growth is expected to be fuelled by evolving consumer preferences, the rise of renewable and bio-based materials, geopolitical influences, stricter environmental regulations, and a heightened focus on health and safety.

Similarly, Malaysia's Chemical sector is dynamic and rapidly evolving, playing a pivotal role in the nation's economic landscape. In 2022, the sector's contribution to the nation's gross domestic product (GDP) increased by 4.9% to RM48.7 billion, its highest level since 2006.[2] Exports also experienced a notable rise of 12.9%, growing from RM86.7 billion in 2021 to RM97.9 billion in 2022. The sector employed 236,414 workers across diverse roles, including manufacturing, engineering, and research and development (R&D).[3]

As a leading global producer and exporter of petrochemicals and palm oil-based oleochemicals, Malaysia's Chemical sector plays an essential role in diverse fields such as pharmaceuticals, agrochemicals, water treatment, construction, paints and dyes, surfactants, personal care, agriculture, and manufacturing, among others.

The Chemical Industry Roadmap 2030 (CIR2030) envisions transforming Malaysia's Chemical sector into a globally competitive and sustainable industry by 2030. Alongside the New Industrial Master Plan 2030 (NIMP 2030), CIR2030 identifies five (5) key opportunities: growing demand for lightweight vehicles and alternative fuels, evolving nutrition and health trends, increased demand for agri-science applications, advancements in construction materials and technologies, and adoption of Industry 4.0. To achieve these goals, CIR2030 focuses on enhancing productivity, fostering innovation, digitalisation, and promoting sustainable practices through three (3) priority segments and 11 priority sub-segments.

Based on the outlook, Malaysia's Chemical sector is set for significant transformation over the next three (3) to five (5) years, driven by advancements in Artificial Intelligence (AI), Digital, and Green Economy. These trends are expected to profoundly impact the Malaysian workforce, necessitating a shift in skills and competencies to meet the evolving demands of the industry.

The impact study for the Chemical sector has identified a total of 51 roles and 21 skill clusters. Among these, 10 job roles (20%) are classified as highly impacted by AI, Digital, and Green Economy, 28 job roles (55%) are medium impacted, and 13 job roles (25%) are low impacted. Additionally, eight (8) emerging roles have been identified to drive future advancements and innovations within the Chemical sector.

The focal point of the impact study centres on roles significantly affected by the growth trends of AI, Digital, and Green Economy. High impacted roles are roles that are at risk of convergence or displacement due to these trends. Therefore, the study identifies viable career pathways and the necessary skill sets for the Malaysian workforce in the sector, ensuring they are prepared for future challenges and opportunities.

Through the impact study assessment, nine (9) initiatives have been identified to adapt to AI, Digital, and Green Economy trends within Malaysia's Chemical sector. These plans aim to harness opportunities and address challenges posed by these transformative trends. Aligning with the needs and aspirations of each stakeholder group will foster innovation, promote skill development, and ensure the sustainable growth of the sector.

These following Recommended Initiatives have been grouped into four (4) stakeholder categories: **Government**, **Industry Players**, **Academia**, and **Training Providers**:

GOVERNMENT

- **IN1** **Provide Funding and Incentives to Encourage Adoption of Emerging Technologies and Practices**
- **IN2** **Upgrade Existing Chemical Parks with Advanced Infrastructure to Keep Pace with Emerging Digital Technologies and Environmental Regulations**
- **IN3** **Attract Foreign Technology Leaders to Malaysia and Promote New Technologies**

INDUSTRY PLAYERS

- **IN4** **Introduce In-House Roadmap for Adoption of Emerging Technologies**
- **IN5** **Encourage Investment in Emerging Digital Technologies**
- **IN6** **Establish Community of Practice (COP) for Sharing of Best Practices**

ACADEMIA

- **IN7** **Collaborate with Industry Experts to Integrate Real-World Practices in Curriculum and Syllabus to Produce 'Ready-To-Work' Graduates**

TRAINING PROVIDERS

- **IN8** **Develop Applicable Training Content by Building Partnership with Industry Experts**
- **IN9** **Enhance Training Delivery and Effectiveness by Onboarding More Credible and Certified Training Providers**

1. Chemicals Market Analysis Report - Size, Share & Forecast Report, 2033
2. Ministry of Investment, Trade and Industry (MITI), Chemical Industry Roadmap 2030, 2023
3. Ministry of Investment, Trade and Industry (MITI), New Industrial Master Plan 2030: Chemical Industry (NIMP 2030), 2023

Chapter 1:
Introduction of the Study

Introduction of the Study

Purpose of the Study

The increasing focus and adoption of AI, Digital, and Green Economy call for a transformative shift in global operating models and workforce, supported by the digitally enabled drive beyond Industrial Revolution 4.0. The study aims to help government, industry players, academia, training providers, and the public to prepare for future workforce demands. The output of this study will contribute to the Malaysia National Skills Registry (MyNSR), a skills taxonomy that will be integrated into the MyMAHIR platform. This platform offers comprehensive insights into industry trends, job roles, required skills, career pathways, and available training programmes across all sectors.

These research and studies cover several sectors, namely Information and Communications Technology (ICT); Food Manufacturing and Services; Pharmaceutical Manufacturing; Medical Devices; Aerospace; Electrical and Electronics; Wholesale and Retail Trade; Energy and Power; Chemical; and Global Business Services.

AI will increasingly impact the nature of work and the broader societal progress

Majority of industry players in Malaysia are conscious about AI and the benefits it brings to organisations. While some have leveraged AI to carry out tasks, many organisations have yet to fully embrace AI as it remains difficult for organisations to justify the expense and effort required to implement AI due to the uncertainty of Return on Investment (ROI). Organisations are also wrestling with how to address AI throughout their operations – not just from a technology perspective but also from the human perspective in terms of roles and skills readiness.

This is also consistent with an inaugural Cisco AI Readiness Index in 2023 where 86% of organisations worldwide are not fully ready to integrate AI into their businesses. Malaysia's AI Readiness tracks that of the Global level, standing at 87% with only 13% considered as "pacesetters".

With the rise of AI, the Malaysian government has launched the National AI Talent Roadmap 2024–2033 to cultivate a skilled workforce to unlock the potential of AI across various sectors. Adding to this momentum, tech giant Microsoft Corp announced a significant investment of RM10.5 billion in Malaysia's cloud and AI infrastructure. Additionally, global tech firms Google and ByteDance will invest RM9.4 billion and approximately RM10 billion to establish data centres and transform Malaysia into a regional AI hub.

Malaysia's digital transformation is key to enhance national competitiveness, empower industries and local enterprises to progress towards high-value added activities

Digital transformation has been a strategic imperative across many organisations for many years. By continuing to embrace digital technologies, Malaysia can significantly elevate the capabilities of its industries and local enterprises. This technological advancement is not just about automating existing processes to enhance productivity, but also about enabling a shift towards higher value activities.

Digital economy is one of Malaysia's key economic pillars, contributing 22.6% to the country's gross domestic product (GDP).[4] This number is set to rise to 25.5% by 2025. To remain relevant and resilient, the Malaysia Digital Economy Blueprint overseen by MyDIGITAL outlines the efforts and initiatives taken to transform Malaysia into a high-income nation that is focused on digitalisation and a regional pioneer in the digital economy.

Malaysia is also making significant strides in Green Economy

When it comes to Green Economy, most organisations in Malaysia today are still driven by compliance to regulations. However, there has been growing awareness and willingness to drive the Environmental, Social and Governance (ESG) agenda at the forefront with concerted efforts from the government, private sector, and public. While progress is being made, ongoing commitment and collaboration across all industries are necessary to ensure a sustainable future for the country.

This is in line with the Twelfth Malaysia Plan (2021–2025) that outlines the nation's aspiration to achieve net-zero greenhouse gas (GHG) emissions as early as 2050. Complementing this, the National Energy Policy (2022–2040) sets the foundation for transforming the energy landscape towards sustainability. In line with these objectives, the Malaysian Government has also developed the National Energy Transition Roadmap (NETR) to accelerate the shift from a traditional fossil fuel-based economy to a high-value Green Economy. Malaysia's efforts are reflected in its leading position in the World Economic Forum Energy Transition Index, ranking 1st in ASEAN and 35th globally.[5]

It is imperative to future-proof Malaysia's workforce for the impact of AI, Digital, and Green Economy

This study aims to provide transformative and strategic inputs to complement the rapid growth of these areas. It will examine how these trends as a whole will reshape Malaysia's workforce in the upcoming three (3) to five (5) years and assess the impact of current and future trends of AI, Digital, and Green Economy; its implications for current and future job roles and skills; the nation's capacity to cater to future workforce demands and needs; and lastly, policy recommendations that the policy makers and agencies, industry players, academia and training providers as a whole can do in spurring the industry forward amidst flexible changes ahead.

This report will provide an overview of the Chemical sector, including its related sub-segments, the key trends and developments relating to AI, Digital, and Green Economy.

More importantly, it will highlight the roles impacted as well as the skills needed to be future-ready for the Chemical sector. These findings are based on engagements with industry associations and key players as well as regulators and government agencies.

The report concludes with Recommended Initiatives for four (4) key stakeholder groups, namely: Government, Industry Players, Academia, and Training Providers.

> **"Microsoft's investments in digital infrastructure and skilling will help Malaysian businesses, communities, and developers apply the latest technology to drive inclusive economic growth and innovation across the country."**
>
> ***Satya Nadella, CEO of Microsoft***

4. Vanessa Gomes, *Catalysing Malaysia's Digital Economy*, September 2022, https://mdec.my/esg-mdcap/content-hub/catalysing-malaysia-digital-economy
5. MIDA, *Malaysia ranked first place in S-E Asia in WEF energy transition index*, July 2030, <https://www.mida.gov.my/mida-news/malaysia-ranked-first-place-in-s-e-asia-in-wef-energy-transition-index/>

Chapter 2:
Approach and Methodology

Approach

A six-pronged approach entailed a blend of qualitative and quantitative research techniques that generated insights and met the objectives desired from this study. The study's outcomes reflect what is happening in each sector today and what is expected of each sector in the next three (3) to five (5) years.

Research Techniques

The qualitative and quantitative research techniques were as follows:

Research Methodology

The study focused on three (3) key trends shaping today's workforce: AI, Digital, and Green Economy. Their definition is outlined below:

01 Artificial Intelligence
Development and use of machine learning models capable of performing tasks that would have required human intelligence (deep learning, computer vision, Natural Language Processing (NLP), reinforcement learning, supervised and unsupervised learning).[6]

02 Digital
Activities and transactions driven by the public and various organisations to produce, adapt and innovate digital technologies and services for enhanced productivity and quality of life (big data analytics, cloud, Internet of Things (IoT), and robotic process automation).[7]

03 Green Economy
Employment growth and income driven by investment in low-carbon, resource-efficient, and socially inclusive economic activities, infrastructure, and assets.[8]

To effectively analyse how the key trends impact existing roles, four (4) key parameters have been defined in the assessment process, as stated below:

AI & Digital

1. **Opportunity to automate data-driven or low-creativity activities that are repetitive or rule-based via AI or other technology tools.**

2. **Human intervention is required despite some or most activities being automated or digitalised, as:**
   - Strategic thinking and problem-solving are vital to making decisions
   - Creative thinking is needed to generate new ideas or ways of working
   - Outcomes need to be communicated or socialised and regulated
   - High importance is placed on human emotions or physical involvement in performing the activity
   - Typically performed by a critical role that holds accountability or a role requiring certification

Green Economy

1. **Impact of the environment on jobs that depend on limited natural resources and produce outputs that are polluting or may pollute the environment.**

2. **Opportunity to diversify, requiring new skills to implement the organisation's Environmental, Social, and Governance (ESG) agenda, which includes:**
   - Environment: Areas for improvement in environmental sustainability
   - Social: Diversity, equity, inclusivity, ethics, and community engagement
   - Governance: Risk management, compliance, reporting, and corporate culture

6. World Economic Forum
7. Malaysia Digital Economy Corporation (MDEC)
8. United Nations Environment Programme (UNEP)

Based on the parameters above, the impact assessment of AI, Digital, and Green Economy on roles will result in one of the following outcomes:

HIGH

Roles at risk of convergence or displacement

Need to pivot to adjacent role and reskill

MEDIUM

Roles still relevant

Need to evolve and upskill to deliver beyond what would traditionally be expected

LOW

Roles not severely impacted

Require ongoing self-improvement to stay relevant

The impact assessment results inform individuals and organisations about the levels of risk faced by job roles in the industry. This information can aid in strategising career development and workforce planning, ensuring relevance amidst advancements in the three (3) key trends.

Key Stakeholders Engaged in the Study

Recognising the importance of on-the-ground perspectives, the impact study gathered insights from key stakeholders across the country, including Government, Industry Players, Academia, and Training Providers. The contributions from these four (4) groups enriched and fine-tuned the study's findings.

Stakeholders and their Contributions to the Study

Stakeholder Groups	Government Entities responsible for enforcing industry regulations and ensuring compliance with standard.	Associations Organisations facilitating networking, advocacy, and knowledge exchange among industry players.	Industry Players Companies actively involved in producing and distributing goods or services within the industry.	Training Providers National and state-specific institutions that offer courses to develop skills and knowledge in various fields.
Key Contributions	• Share inputs on industry trends. • Validate high-level impact assessments. • Recommend initiatives.	• Identify selected industry players. • Share inputs on industry trends. • Validate high-level impact assessments. • Recommend initiatives.	• Validate industry trends. • Validate detailed impact assessments. • Identify future roles and skills requirement. • Provide a view of capacity demand and number of highly impacted workforce. • Recommend initiatives.	• Recommend training providers and suitable programmes mapped to skills. • Suggest new training programmes to close existing and future gaps. • Recommend initiatives.

Stakeholders' Selection Criteria

Selecting the right stakeholders ensures the impact study benefits from diverse perspectives and relevant expertise. The four (4) criteria used to identify stakeholders for engagement are:

01
HOLISTIC SECTOR COVERAGE
Comprehensive coverage of industry players across all sub-sectors and the entire value chain

02
STRONG BRAND PRESENCE
Widespread visibility and influence within the sector

03
SIZEABLE EMPLOYMENT COVERAGE
Comprehensive coverage and employee counts across all roles included in the assessment

04
SIGNIFICANT TURNOVER
Ensure a diverse mix of industry players, including large firms with high turnover

Over the course of the study (April - September 2024), a total of **34** experts from **17** organisations were consulted in the **13** engagements conducted.

Key Facts and Figures of Impact Study Stakeholder Engagements

In-Depth Interviews	Validation Workshops
Industry Players : 15	Associations : 2

Chapter 3:
Sector Overview

The Chemical sector is advancing rapidly globally and in Malaysia through AI, Digital, and Green Economy practices. AI optimises production, reduces waste, accelerates molecule discovery, and improves predictive maintenance, while Generative AI creates novel content. Digital tools enhance tracking, risk management, and stakeholder engagement across core products and services. Green Economy initiatives, strongly supported by the government, focus on low-carbon, resource-efficient, and socially inclusive activities, driving income and employment growth. These advancements are creating a skills gap, as demand for new expertise rises, which may lead to job displacement. However, they also offer opportunities for those willing to upskill and adapt. This chapter examines the Chemical sector from both global and Malaysian perspectives, highlighting how macro trends influence its evolution.

Overview of the Global Trends in the Chemical Sector

The global Chemical sector was valued at USD5.1 trillion (RM22.16 trillion) in 2023 and is estimated to grow to USD7.8 trillion (RM33.9 trillion) in 2028, with a CAGR of 8.7%.[9] This will be driven by shifts in consumer preferences, renewable and bio-based materials, geopolitical factors, stricter environmental regulations, health and safety prioritisation. This is also spurring new developments in the fields of sustainability and green chemistry, digital transformation, circular economy, advanced materials and nanotechnology, supply chain resilience, digitalisation and Industry 4.0.

The sector plays a crucial role in diverse fields such as pharmaceuticals, agrochemicals, water treatment, construction, paints and dyes, surfactants, personal care, agriculture, and manufacturing, among others. It encompasses a wide range of chemical products, from basic chemicals like petrochemicals to specialty chemicals used in flat screen displays and 3D printing.

As the sector adapts to an increasing global population and urbanisation, it faces challenges such as environmental concerns and stringent regulations. The push for sustainability has become more prominent than ever before.

That said, the sector is faced with several challenges such as environmental concerns and stricter regulations, pushing companies to reduce pollution and create greener products. Unpredictable raw material prices and supply chain disruptions, particularly due to the impact of the COVID-19 pandemic and geopolitical tension, are making the sector less stable. There is also an increased demand to invest in digital technologies and AI into operations which require huge investment, adding another layer of complexity for the sector.

9. The Business Research Company, Chemicals Global Market Report 2024, <https://www.thebusinessresearchcompany.com/report/chemicals-global-market-report>

Five (5) key global trends in the Chemical sector are driving the sector's growth:

01
Change in consumers' preferences due to concerns about the environment

- There are more demands for autonomous mobility, lightweight vehicles, electrification, and alternative fuels which will drive growth in battery and electronic chemicals, engineered polymers and high-performance plastics.
- Growing health concerns among customers are driving the focus into nutrition and healthy lifestyle which will benefit the food ingredients market and preventive medicines.

02
Rising global geopolitical tensions are causing shifts in trade patterns

- Geopolitical tensions in the Western part of the world is causing a redirection of trade patterns. Asia as a region is becoming more important for global growth, accounting for more than two-thirds of growth, and roughly one-third of global trade.

03
Change in market demand as developing countries grow their needs for chemical product

- Future demand growth will likely come from South Asia, Latin America, the Middle East, North Africa, and Southeast Asia, with Vietnam and Indonesia leading the demand in Southeast Asia.
- Rapid urbanisation in developing countries increases the need for new housing in cities, which will result in greater demand for newer materials and technologies to support the construction sector.
- Electric Vehicle (EV) adoption in these regions will also support greater demand for lightweight materials, parts and batteries production.

04
Advancement in digital technologies as part of Industry 4.0 has led to newer tools for development of advanced materials

- Digital advancement such as IoT and 3D printing will require more carbon-based sensor technologies with better sensitivity, and will result in more demand for new material development.
- This will increase consumption of chemical-derived products such as silicon, graphene and carbon nanotubes.
- The rising demand for advanced and specialty materials has significantly boosted the need for automation, robotics, and software development to effectively manage data across various applications.

05
Stricter regulations and pressure from consumer expectations are driving the sector towards greener, low-carbon operations

- Increasing consumer concerns about environmental impact and transparency have prompted companies to focus more on recycling and adopting sustainable practices.
- Agri-science applications such as crop protection and seed health, as well as bio-based materials will have an important role in meeting these demands.
- Digitalisation of documents and processes will provide greater transparency of the operations and allow for data-driven decision making and analysis.
- Stricter environmental regulations have compelled companies to embrace a circular economy model that emphasises on reducing waste, reusing materials, and recycling products to minimise environmental impact. This shift includes the adoption of chemical recycling and other innovative solutions.

Overview of the Malaysian Trends in the Chemical Sector

The Chemical sector is a vital part of Malaysia's manufacturing sector, playing a significant role in the nation's economy. In 2022, the sector's GDP contribution rose by 4.9% to RM48.7 billion, marking the highest level since 2006. Exports also surged by 12.9%, increasing from RM86.7 billion in 2021 to RM97.9 billion in 2022.[10] This diverse sector includes a wide array of products such as petrochemicals, fertilisers, oleochemicals, and specialty chemicals, which are vital to other key sectors like pharmaceuticals, electronics, automotive, and agriculture, supplying essential raw materials and intermediates.[11]

A snapshot of Malaysia's Chemical sector

GDP contribution	**RM48.7 bil**	**Number of Employees**	**Chemical 236,414**
Nature of sector	**The sector is highly concentrated, with over 90% made up of SMEs, while the remaining share consists of MNCs. MNCs predominantly contribute to the production of base chemicals or building blocks and organic chemicals, which account for more than 50% of total chemical output.**		

Malaysia is one of the leading global producers and exporters of petrochemicals and palm oil-based oleochemicals. In 2022, the sector employed 236,414 workers across diverse roles, including manufacturing, engineering, and R&D. The workforce is highly skilled and is committed to continuous improvement and technological advancement. The COVID-19 pandemic in 2020 has disrupted the sector by shifting demand patterns and affecting supply chains. While still recovering, the Chemical sector is showing gradual improvements in production output and demand stabilisation, as demonstrated by substantial growth in both GDP contribution and exports.[12]

Sub-sectors in the Chemical Sector

Sub-sectors	Description
Organic Chemicals	Production of carbon-based compounds that spans a wide range of substances including solvents, petrochemical derivatives, and specialty chemicals used in cosmetics and food additives
Non-organic Chemicals	Production of compounds that do not contain carbon-hydrogen (C-H) bonds, which are fundamental to various industry processes and used in sectors like manufacturing, water treatment, and electronics
Bio-based Chemicals	Production of compounds derived from renewable biological sources such as plants, algae or waste materials. Malaysia focuses on utilising agricultural biomass, particularly oil palm to promote sustainability

10. Chemicals Market Analysis Report - Size, Share & Forecast Report, 2033
11. Ministry of Investment, Trade and Industry (MITI), New Industrial Master Plan 2030: Chemical Industry (NIMP 2030), 2023
12. Ibid

Chemical Industry Roadmap 2030

The CIR2030 outlines Malaysia's strategic vision for the Chemical sector, aiming to transform it into a globally competitive and sustainable force by 2030. The roadmap emphasises on enhancing productivity, fostering innovation, embracing digitalisation, and promoting sustainable practices.

CIR2030 has highlighted three (3) priority segments, and 11 priority sub-segments based on market attractiveness, strategic relevance and advantage as the sector continues to grow to become a key contributor to the economy:[13]

Priority segment 01 Base Chemicals and Intermediates

- Fertilisers – Composed of nitrogen, phosphorus, and potassium to supply nutrient to soil or plant tissues.
- Oleochemicals – Derived from plant fats as core building blocks for personal and home care products such as shampoo, detergent, and toothpaste.
- C1 Intermediates – Used for various industrial purposes such as base materials for acrylic plastic, paints, and clothing fibres.

Priority segment 02 Plastics and Polymers

- High performance composites – Used as composite materials such as fibres and fillers for the aerospace, high-end automotive, and construction industries.
- Synthetic rubber – Polymers used to manufacture tyres, automotive parts, and medical equipment such as gloves.
- Plastics (commodity, engineering, high-performance) – A supply chain enabler and support other sectors including construction, automotive, and food and beverages (F&B).

Priority segment 03 Specialty Chemicals

- Agrochemicals – Utilised in agriculture to improve crop yield and pest control.
- Care chemicals – Used to produce home care, personal care, and industrial cleaning products such as soaps and detergent.
- Nutrition chemicals – Formulated in wide range of food-related chemicals including flavouring, food additives, feed additives, and digestion enhancers.
- Electronic chemicals – Used in the electronic sector to manufacture semiconductor-related components such as silicon, resins, and ceramic substrates.
- Construction chemicals – Formulations used for cement, concrete, and other construction materials to increase durability and improve performance.

13. Ministry of Investment, Trade, and Industry (MITI), Chemical Industry Roadmap 2030, 2023

Impacts of AI, Digital, and Green Economy on the Chemical Sector

A Challenges and Opportunities

Challenges

To realise the goals outlined in CIR2030, the sector is also addressing several key challenges:

Upgrading local research, development, commercialisation, and innovation (RDCI) capabilities to match the standards of leading chemical-producing countries such as Germany and Japan

- Overcoming limitations in industry-academia integration, addressing gaps in relevant expertise, increasing funding, and raising awareness of technical standards.
- Expanding the current pool of approximately 1,000 specialists with composite skill sets, which falls short of ecosystem requirements.
- Addressing the shortage of high-skilled talent in specialty chemicals, which is hindering the development of new formulations and compounds needed to meet sector demands. Malaysia currently depends on foreign players to produce specialty chemicals for sectors like the semiconductor sector.

Specific incentives are required for expansion of the Chemical sector rather than broad incentives applicable to the entire manufacturing sector:

- Targeted incentives are essential to enhance the sector's global competitiveness and create a more attractive environment with increased financial support.
- This is particularly critical for sectors such as nutraceuticals and flavours and fragrances, which demand substantial upfront investment and intensive technology and research efforts.

Presently, SMEs and start-ups, albeit in small number, are beginning to engage in the development of sustainable products as the sector transitions toward circular ecosystem

- This may be due to the lack of digital platform solutions, education support, and best-practice guidance that hinder the development.
- There are also limited policies and regulations in areas such as carbon reduction, plastic recycling and chemical waste management.
- Transitioning into energy efficient systems requires high capital investments. SMEs often lack the financial resources to invest in green technologies such as advanced recycling processes and R&D.

Limited infrastructure for testing facilities and waste management facilities to support the growth of sub-segments such as agrochemicals.

- There is currently no local testing facility for advanced materials.
- Currently, the government handles the majority of the chemical waste management. More participation from private operators is needed to further enhance the system and support the SMEs who often do not own an in-house waste management system.
- The agriculture sector, for instance, faces a dire situation on labour shortage, hence the need for improved fertiliser technologies such as slow-release fertilisers to combat this issue.

Chemical parks such as Gebeng Industrial Park and Kerteh Integrated Petrochemical Complex (KIPC) will require high value-added products such as high-performance composites, green chemicals, and polymers

- Investment is required in R&D and modern infrastructure to support the development of high-performance composites, advanced materials, and green chemicals.
- Some companies, especially the SMEs lack state-of-the art facilities and advanced technology, limiting their ability to produce more value-added products.

The rate of Industry 4.0 technology is still relatively limited mainly due to:

- Lack of collaboration between chemical manufacturers and Industry 4.0 technology providers
- Low financing support for technology adoption.
- Private technology providers lack familiarity and expertise to cater for specific needs of the sector, which often requires extensive customisation.

Besides attracting and retaining talents, one of the key challenges is the upskilling of workers

- There is also a shortage of low-skilled workers in Malaysia's plastics sector and inability to retain a suitable volume of local workers.
- Resistance to change coupled with steep learning curve for older generations also make the transition to Industry 4.0 a significant challenge.

Opportunities

The CIR2030 and NIMP 2030 identified five (5) key opportunities for the Chemical sector:

Growing Demand for Lightweight Vehicles and Alternative Fuels:
There is an increasing need for lightweight vehicles, electrification, and alternative fuels, driven by the push for more efficient and sustainable transportation solutions. The demand for chemical-derived products, such as those used in batteries and electronics, is surging due to the rapid advancement of semiconductors and Electric Vehicles (EVs). This growth creates opportunities across the semiconductor value chain for specialty chemicals in production processes.

Changes in Nutrition and Health Trends:
The ageing population and heightened awareness of health and hygiene post COVID-19 are fuelling growth in nutrition and personal care chemicals, reflecting shifting lifestyle preferences.

Increased Demand for Agri-Science Applications
Food security concerns and low agricultural productivity are driving the demand for agrochemicals, with a particular focus on crop protection, production, and seed enhancement.

Advancement in Construction Materials and Technologies
The expanding population and urbanisation are creating a demand for innovative construction materials, such as advanced concrete admixtures and sealants. Additionally, the rise of EVs is spurring the need for specialty materials in infrastructure development.

Adoption of Industry 4.0 Technologies:
The integration of advanced technologies like multi-functional sensors and 3D printing is boosting the demand for high-performance composites.

> **Transitioning to a Green Economy is a massive undertaking for Malaysia, as it is globally. One of the biggest hurdles is the readiness and mindset required to embrace change, which starts with cultural transformation and a shift in attitudes. Another significant challenge is the lack of skills and resources needed to adopt these technologies. For many industries, particularly SMEs, the financial investment necessary to implement green practices can be a barrier. The shift toward sustainability demands not only innovation but also significant support to ensure that all sectors, regardless of size, can participate in this global movement**
>
> ***Rosmawati Haron, Assistant General Manager, HR, Kaneka Malaysia***

B Impacts of AI, Digital, and Green Economy

Artificial Intelligence

AI Trends

The sector is actively embracing AI to harness its extensive benefits throughout the value chain, such as optimising production, minimising waste, expediting molecule discovery, and enhancing predictive maintenance.[14] Growth in disruptive technologies like Generative AI, boasts the ability to create novel content, for instance, synthesising new compounds with specific desired properties.

The Malaysian Government is driving this transformation through the Industry4WRD policy and the MyDIGITAL blueprint. These initiatives offer incentives, funding, and training programmes designed to accelerate AI adoption across all manufacturing sectors, including Chemical.

AI Impact

R&D:
AI technologies are revolutionising the design and development of new polymers and catalysts, as well as conducting in-depth molecular activity studies. These advancements enable the prediction of new formulations, accelerate the discovery process, and streamline product development.

Production:
AI-driven operations are improving the reliability of chemical equipment and reducing downtime. This integration supports companies in meeting ESG compliance standards and enhances the detection of chemical contaminations within plants, thereby ensuring both product quality and worker safety. Key applications include contamination detection, leak detection, gas quality assurance, and predictive maintenance.

Cost reduction:
Implementing AI-based energy-efficient logistics and shipping operations can significantly reduce costs by optimising delivery processes and enhancing real-time shipment visibility. These applications help streamline logistics, ensure more efficient use of resources, and provide greater transparency throughout the shipping process, ultimately leading to cost savings and improved operational efficiency.

Key drivers for growth of AI/GenAI

- Increase demand for novel chemicals with specific properties
- Need for cost and time reduction for molecule development
- Increase need for sustainable and circular solutions
- Requirement for advanced quality control systems

Digital

Digital Trends

Chemical companies are increasingly recognising the potential of digital technology, particularly in advancing sustainability efforts. Digital solutions enable seamless tracking, risk management, and stakeholder engagement processes across core products and services.

Research indicates that in four (4) out of ten chemical companies, CEOs are placing a strong emphasis on digitalisation to achieve their sustainability goals. Furthermore, around 70% of CEOs see medium to high potential in leveraging technology and digitalisation to implement these goals more effectively and efficiently.

One notable instance is a pilot project for a blockchain solution by the Port of Rotterdam, which has demonstrated improved efficiency throughout the supply chain, resulting in:

- **Cost savings of at least 30%**
- **20% faster and more efficient processing of documents and goods**
- **Less manual work, lower risk of errors, and better insights into the status of the cargo**

14. EY Research and Insights for AI in Chemical Sector October 2023

Digital Impact

Digital Twin Adoption:
Digital twin technology enables the manufacturers to create virtual replicas of plants, allowing them to stimulate processes in a virtual environment before implementing them in the real world. The system assists to predict equipment failures, and optimise production schedules leading to more efficient, safer processes with reduced operating costs.

Blockchain in Supply Chain:
Global players are utilising blockchain to improve transparency, traceability, and automate mass balance calculations to ensure compliance with regulations. The system also enables automated and secure record-keeping of data to help with transparent auditing.

Data Analytics and Virtual Reality:
Big data analytics is helping manufacturers to make informed decisions by analysing historical data to enhance efficiency, predict possible hindrances and derive solutions. Digital experiences enhance customer understanding of products e.g. coatings players utilising AR/VR for immersive customer experience.

Green Economy

Green Economy Trends

The adoption of Green Economy practices has become a crucial aspect of the Chemical sector, bolstered by strong government support. Investments in low-carbon, resource-efficient, and socially inclusive economic activities, as well as infrastructure and assets are driving growth in income and employment.

Green Economy Impact

Linear to Circular Economy Model:
The concept of a circular economy is gaining traction, with chemical companies increasingly investing in recycling and waste reduction initiatives. They are exploring ways to design products that promote reusability, aiming to maximise the lifespan of raw materials and chemicals. At the end of the product lifecycle, materials are collected and recycled, helping to eliminate waste and pollution.

Chemical Recycling:
There is a growing shift towards chemical recycling technologies, which help keep plastics in circulation and out of landfills. This method is more versatile than mechanical recycling, as it can handle a wider variety of plastics and often produces materials of higher quality than virgin plastics. This shift also creates opportunities to develop next-generation materials, such as bio-based polyester alternatives.

Global pressure to boost environmental practice:
According to the World Economic Forum, more countries are introducing stricter environmental regulations to address the worsening climate crisis, spurring innovation in cleaner technologies and products among companies. The Taskforce on Nature-related Financial Disclosures (TNFD) was introduced with the aim of preserving nature and biodiversity, while also helping organisations understand and disclose their impact and dependencies on nature.[15]

15. World Economic Forum (WEF), How the new financial disclosure framework will encourage companies to protect nature, 19 September 2023, <https://www.weforum.org/agenda/2023/09/how-the-new-financial-disclosure-framework-will-encourage-companies-to-protect-nature-sdim23/>

State of Trends Adoption

Artificial Intelligence

Adoption of AI is progressing slowly due to costly Investments required to introduce AI and digitalisation:

- The cost of integrating AI into existing systems is costly, especially for SMEs.
- Implementing AI technologies requires significant investments in infrastructure, software, and training.
- Current government incentives broadly covers the entire manufacturing sector, and does not particularly specify the Chemical sector and SMEs.

There is significant talent shortage of skilled professionals who can develop, implement and manage AI systems in this sector:

- Scarcity of skilled professionals in AI and data science can delay the implementation and impact the maintenance of AI systems.
- The companies are struggling to find sector-ready talent to fill in the gaps, and investment is needed to train the existing workforce.

Local manufacturing facilities operate with legacy system that may not be compatible with modern AI technologies:

- Transitioning to AI requires a significant amount of time and resource, to ensure that it complies with existing regulations in terms of safety and environmental trends and impact.
- Employees and management who are accustomed to existing methods and may not be ready to embrace new AI-driven processes, thus slowing the adoption rate.

Case Study

BASF We create chemistry · CITRINE INFORMATICS · KOCH · C3.ai

- In its product development, **BASF** has collaborated with **Citrine Informatics** to leverage AI in accelerating the development of environmental catalyst technology, speeding up material discovery.
- **KOCH** and **C3.ai** collaborated to explore AI and Machine Learning for predictive maintenance on the manufacturing line and leveraged data analytics to streamline processes, maximise efficiency and reduce costs.

Digital

Manufacturers have digitised their production processes to improve monitoring and gain better insights for process optimisation and predictive maintenance:

- The integration includes sensor devices installed throughout the plant to collect data on various parameters such as temperature, pressure, and chemical composition which can be monitored directly from the control room.
- This gives real-time visibility to optimise daily operations and forecast equipment failure by analysing historical data, allowing for scheduled maintenance and reduce downtime.

Digital integration has streamlined supply chain processes, including weighbridge operations:

- Visibility into the inventory enables better demand forecasting and inventory optimisation as production team is now able to directly monitor client's request and inventory levels to plan the production accordingly.
- In some organisations, the system is extended up to the weighbridge operation, whereby it no longer requires on-site and manual operator as instructions for the incoming/outgoing fleet can be done directly from the control room.
- Automation of tasks previously performed by weighbridge operators lead to a reduction in labour costs, improved efficiency, and record accuracy.
- Due to the large acquisition of data, companies are focusing on data management, data warehousing and proper integration between the systems.

Case Study

DUPONT EASTMAN CITRINE INFORMATICS

- **DuPont** operates a digital centre in the United States, where it leverages AI, ML, AR/VR, predictive analytics, connected devices, and IoT to digitally transform its operations, reduce expenses, and streamline manufacturing.
- **Eastman** partnered with **Citrine** to establish a Digital Centre of Excellence (DCoE) aimed at scaling up data-driven product development across various application areas within the business.

Green Economy

Companies have taken measures to proactively implement sustainable business and manufacturing practices in line with the government aspirations to meet environmental, economic and social needs without compromising the progress and success of the sector

Malaysian Government has taken proactive steps to improve sustainability practices within the Chemical sector via CIR2030:

- One of the targets is to increase plastics and synthetic rubber recycling rate to 50% and reduction of greenhouse gas emission by 35% by 2030.
- The government also aims to establish Malaysia as top five (5) bioplastics manufacturers in Asia through strong local oleochemical base.

Local companies are embarking on new economic models focusing on circular economy in pursuing New Plastic Economy agenda:

- A collaboration between the Government, industry players, and NGO focuses on innovation, infrastructure, education and waste management to sustainably manage plastics.
- The objective is to recycle plastic waste that cannot be recycled by conventional and mechanical methods and turn wastes into valuable resources including new feedstock.[16]

Bursa Malaysia is implementing a compulsory sustainable reporting for all Public Listed Companies (PLCs) to enhance the transparency and accountability regarding their ESG practices:

- Companies are required to provide stakeholders with relevant information about the company's sustainability efforts and impacts.
- This helps to identify and manage ESG risks, ensuring business' long-term resilience.

Case Study

LG Chem CJ CHEILJEDANG SUMITOMO CHEMICAL Mitsui Chemicals TotalEnergies Circular UKRI Innovate UK Recycling Technologies EVONIK Leading Beyond Chemistry

- **LG Chem** partnered with food giant **CJ Cheil Jedang** to produce bio-based nylon, an eco-friendly alternative to traditional synthetic polymers.
- **Sumitomo Chemical** and **Mitsui Chemical** engaged in the development of TCFC guidance and to enhance nature related disclosures.
- **Total Energies**, **Circular**, **Innovate UK**, and **Recycling Technologies** leveraged blockchain to provide traceability of recycled materials, from the waste source to recycled polymers.
- **Evonik** launched its EUR150 million (RM733 million) Sustainability Tech Fund in 2022, which invests in circular economy, alternative raw materials, future mobility, H2 economy, renewable carbon and clean energy.

16. Department of Statistics Malaysia and TalentCorp Demand Model Projection https://www.petronas.com/pcg/sustainability/new-plastics-economy#:~:text=To%20support%20this%20roadmap%2C%20PCG%20is%20spearheading%20a,and%20the%20public%2C%20aims%20to%20sustainably%20manage%20plastics.

Chapter 4: Key Findings

Overview of Roles and Skills

As the Chemical sector evolves under the influence of AI, Digital, and Green Economy, it is essential to understand how these transformations will impact job clusters and roles. As these changes continue, it is crucial to explore how job functions are shifting and what new roles are emerging in response to these trends.

While some jobs may be displaced or transformed, new opportunities will emerge, emphasising the need for adaptive skills and continuous learning. Policymakers and industry leaders will need to focus on training and support to effectively navigate this evolving landscape.

The impact study encompasses an in-depth analysis of all the key roles and components within the Chemical sector's value chain.

Value Chain

Feedstock → Base Chemicals / Building Blocks → Intermediates → Polymers → End Consumer

Job Cluster

Site Management	Production	Engineering and Maintenance	Quality Assurance and Quality Control	Technical Service and Applications	Health, Safety and Environment	Research and Development	Logistic and Warehousing
• Oversee overall site operations, set strategic goals, ensure compliance with regulations, manage budgets, and make high-level decisions • Responsible for maintaining profitability and safety while ensuring the production targets are met	• Responsible for the day-to-day manufacturing processes • Manage production schedules, operate machinery, ensure product quality and maintain production efficiency while adhering to safety procedures	• Responsible for the maintenance and improvement of plant's equipment, infrastructure, and processes • Design, install, and maintain machinery and equipment, to ensure smooth operations • Perform regular maintenance and troubleshoot issues within the production setup	• Ensure all products are meeting the required quality standards before being distributed • Implement and monitor quality control process, conduct inspections and tests, ensuring compliance with industry standard	• Provide technical support and expertise to stakeholders, troubleshoot product-related issue, and advise on product applications • Collaborate with R&D to refine the products based on feedback from customers and market needs	• Responsible to maintain a safe work environment and minimise the plant's environmental impact • Implement and enforce safety protocols, conduct risk assessments, ensure compliance with environmental regulations, and promote safety culture • Handle incident investigations and continuous improvement in safety practices	• Focus on innovation and developing new products or improve existing one • Conduct research, experiment with new materials and process, and develop new chemical products • Improve product formulations, reduce costs, and ensure new products meet market demands and regulatory requirements	• Manage storage and movement of raw materials and finished products • Coordinate the storage, handling and transportation of materials and product • Manage inventory, optimise warehouse space, and ensure timely delivery • Work closely with production and sales to ensure smooth supply chain operations
Role Functions							
• Production • Engineering • Health, Safety, and Environment (HSE)	• Production • Production Planning	• Maintenance • Construction • Project Engineering	• Quality Assurance • Quality Control	• Product Application • Technical Service	• Process Safety • Environment • Occupational Hygiene	• R&D • Product Development • Product Testing	• Warehousing • Inventory • Materials Handling

Consolidated Job Clusters, Roles, and Skills in Chemical Sector

8 Job Clusters

Site Management (3 Job Roles)	**Production** (6 Job Roles)	**Engineering and Maintenance** (18 Job Roles)	**Quality Assurance and Quality Control** (5 Job Roles)
Technical Service and Applications (4 Job Roles)	**Health, Safety and Environment** (5 Job Roles)	**Research and Development** (3 Job Roles)	**Logistic and Warehousing** (7 Job Roles)

51 Job Roles

21 Skills Clusters

(Categorised into 19 specific skill clusters and 2 basic skill clusters)

Specific Skills

Agile and Continuous Improvement (1 skill)	**Automation and Robotics** (2 skills)	**Business Operation Management** (2 skills)	**Customer, Vendor, and Stakeholder Management** (4 skills)
Data Development and Implementation (1 skill)	**Engineering and Maintenance** (20 skills)	**General Business Management** (4 skills)	**Green Manufacturing Practice** (3 skills)
Health, Safety, and Environment (HSE) (29 skills)	**People Management and Development** (1 skill)	**Product and Services** (1 skill)	**Project and Process Management** (9 skills)
Quality Management (12 skills)	**Research and Development** (5 skills)	**Risk Management, Compliance, and Governance** (5 skills)	**Software Development and Implementation** (1 skill)
Supply Chain and Logistics Management (8 skills)	**Technology Management** (6 skills)	**Warehouse and Inventory Management** (12 skills)	

Basic Skills

Innovation and Delivery (8 skills)	**Social Intelligence** (7 skills)

141 Skills

Which comprises 126 Specific Skills and 15 Basic Skills

Job Clusters and Roles

The impact study focuses on roles significantly affected by the growth of AI, Digital, and Green Economy. It aims to identify viable career pathways and necessary skills for the Malaysian workforce while highlighting emerging roles driven by these trends to enhance the competitive advantage of the industry.

The impact study for the Chemical sector identified 59 critical roles across eight (8) job clusters: 51 established roles essential for maintaining sector standards and operational efficiency, and eight (8) emerging roles that are set to drive future advancements and innovations.

Job Clusters	Roles
Site Management	1. General Manager / Director Production 2. General Manager / Director / Chief Engineer 3. General Manager / Director Health, Safety and Environment (HSE)
Health, Safety, and Environment (HSE)	1. HSE Manager 2. HSE Executive / Assistant 3. Environment Officer 4. Occupational / Industrial Hygiene Officer 5. Process Safety
Technical Service and Applications	1. Application Chemist / Senior Application Chemist 2. Senior Technical Service Engineer 3. Technical Service Engineer 4. Technical Service Manager
Production	1. Production Senior Manager 2. Production Manager 3. Production Supervisor / Superintendent 4. Production Technician 5. Process Engineer 6. Production Planner
Quality Assurance and Quality Control (QA & QC)	1. Laboratory Chemist 2. Laboratory Supervisor 3. Laboratory Analyst 4. QA Engineer 5. QA & QC Manager
Research and Development (R&D)	1. R&D Manager 2. R&D Chemist 3. R&D Assistant / Laboratory Technician
Engineering and Maintenance	1. Maintenance (Mechanical) Manager 2. Maintenance (Mechanical) Engineer / Senior Engineer 3. Maintenance (Mechanical) Technician 4. Maintenance (Electrical) Manager 5. Maintenance (Electrical) Engineer / Senior Engineer 6. Maintenance (Electrical) Technician 7. Maintenance (Instruments) Manager 8. Maintenance (Instruments) Engineer / Senior Engineer 9. Maintenance (Instruments) Technician 10. Maintenance (Civil & Structural) Manager 11. Maintenance (Civil & Structural) Engineer / Senior Engineer 12. Maintenance (Civil & Structural) Technician 13. Maintenance (Material, Corrosion and Inspection) Manager 14. Maintenance (Material, Corrosion and Inspection) Engineer / Senior Engineer 15. Maintenance (Material, Corrosion and Inspection) Technician 16. Maintenance Planner 17. Construction Engineer 18. Project Engineer
Logistic and Warehousing	1. Warehouse / Inventory Manager 2. Warehouse / Inventory Executive 3. Warehouse Storekeeper / Inventory Coordinator 4. Forklift Operator 5. Weighbridge Supervisor 6. Weighbridge Operator 7. Materials Coordinator

Skills Clusters and Skills

The skills clusters were further categorised into two (2) groupings: basic skills and specific skills, with 15 in the former and 126 in the latter.

Skills Category	Skills Clusters
BASIC SKILLS Essential skills required for a person to be fit for a job	**Innovation and Delivery** • Adaptability and Resiliency • Change Management • Cognitive Skills • Critical Thinking • Digital and AI Fluency • Innovative Thinking • Learning Agility • Sustainability Awareness
	Social Intelligence • Coaching and Mentoring • Communication • Conflict Management • Empathy • Influencing and Negotiation • Planning and Organising • Teamwork and Collaboration
SPECIFIC SKILLS Skills relating to a specific task or situation. It involves both understanding and proficiency in such specific activity that involves methods, processes, procedures, or techniques	**Agile and Continuous Improvement** • Continuous Improvement
	Automation and Robotics • Automated Manufacturing Maintenance • Automated System Design
	Business Operation Management • Operations Reporting Protocol • Production Planning and Scheduling
	Customer, Vendor, and Stakeholder Management • Culture Awareness and Sensitivity • Customer Relationship Management • Partnership and Collaboration • Stakeholder Management
	Data Development and Implementation • Big Data Analytics

Skills Category	Skills Clusters
SPECIFIC SKILLS Skills relating to a specific task or situation. It involves both understanding and proficiency in such specific activity that involves methods, processes, procedures, or techniques	**Engineering and Maintenance** • Civil and Structural Engineering Management • Commissioning and Start-Up • Electrical Engineering • Electrical Field Maintenance • Engineering Support • Equipment and System Value Engineering • Front-End Engineering Design • Geotechnical Engineering Management • Inspection Engineering Management • Instrumentation and Control Design Engineering • Instrumentation, Control Field, and System Maintenance • Maintenance Planning and Scheduling • Mechanical Field Maintenance • Mechanical Rotating Equipment Engineering • Mechanical Static Equipment Engineering • Preventive Maintenance • Process Analyser Maintenance • Reliability Engineering • Structural Testing • Technology Road Mapping
	General Business Management • Budget Management • Business Networking • Cost Management • Resource Management
	Green Manufacturing Practice • Eco-Design Principles • Sustainable Landscapes • Sustainable Manufacturing
	People Management and Development • People and Performance Management
	Project and Process Management • Asset Integrity Management • Control Room Operations • Engineering Drawing Interpretation • Human Factors in Job Design • Maintenance Integrity and Reliability • Plant Turnaround • Process Control • Process Engineering Design • Project Management
	Product and Services • Product Design and Development

Skills Clusters and Skills (Continue)

Skills Category	Skills Clusters
SPECIFIC SKILLS Skills relating to a specific task or situation. It involves both understanding and proficiency in such specific activity that involves methods, processes, procedures, or techniques	**Health, Safety, and Environment (HSE)** • Asbestos Handling • Behavioural Safety Management • Biological Hazards Management • Cleaning Chemical Handling • Confined Space Management • Dangerous Goods Management • Design for Safety • Engineering Safety Standards Interpretation • Environmental Awareness • Environmental Management System • Environmental Remediation • Ergonomics Hazards Management • Hazard Control in Laser Devices • Hazardous Materials Identification • Hazardous Substances Impact Evaluation • Incident Investigation • Indoor Air Quality Management • Local Exhaust Ventilation System Management • Major Hazard Installation Safety Case Management • Noise and Vibration Control • Process Safety Management • Radioactive Materials and Irradiating Apparatus Management • Safe System of Work Development and Implementation • Safety Integrity Levels Management • Thermal Stressors Management • Warehousing / Cargo-related Occupational Health and Safety Management • Waste Disposal Management • Waste Treatment Management • Workplace Safety and Health (WSH) Business Case Development
	Quality Management • Audit Compliance • Equipment Preparation for Mechanical Work • Feedstock and Product Transfer Operations • Materials Specification • Operations Troubleshooting • Plant and Equipment Integrity • Process Quality Management • Quality Assurance Management • Quality Control Management • Technical Inspection • Test Planning • Unit and Utilities Operations
	Research and Development • Laboratory Equipment Maintenance and Calibration • Laboratory Operations • Research and Development Management • Research and Information Synthesis • Sample Management

Skills Category	Skills Clusters
SPECIFIC SKILLS Skills relating to a specific task or situation. It involves both understanding and proficiency in such specific activity that involves methods, processes, procedures, or techniques	**Risk Management, Compliance, and Governance** • Business Continuity Management • Business Continuity Planning • Corporate Governance • Crisis and Disaster Recovery Management • Risk Management
	Software Development and Implementation • Cloud Computing
	Supply Chain and Logistics Management • Material Loading and Unloading Administration • Non-Conformance Identification • Order Fulfilment Administration • Procurement and Construction • Procurement Management • Supply Chain Management • Transport Management System Administration • Vendor Management
	Technology Management • Building Information Modelling Application • Robotic and Automation System • Robotic and Automation Technology • Systems Integration • Technology Application • Technology Infrastructure Management and Integration
	Warehouse and Inventory Management • Cross Docking • Inventory Control Management • Inventory Management • Warehouse Administration • Warehouse Automation Application • Warehouse Facility Management • Warehouse Facility Security Control • Warehouse Layout Design • Warehouse Maintenance and Housekeeping • Warehouse Management System Administration • Warehouse Performance Measurement • Warehouse Space Utilisation

In-Demand Skills

The in-demand skills in the Chemical sector include:

Skills Category	Skills Clusters	
Top Basic Skills	**Innovation and Delivery**	
	1. Adaptability and Resiliency	5. Learning Agility
	2. Digital and AI Fluency	6. Cognitive Skills
	3. Sustainability Awareness	7. Innovative Thinking
	4. Critical Thinking	
	Social Intelligence	
	8. Communication	10. Empathy
	9. Teamwork and Collaboration	
Top Specific Skills	**Agile and Continuous Improvement**	
	1. Continuous Improvement	
	Health, Safety, and Environment (HSE)	
	2. Environmental Management System	4. Incident Investigation
	3. Environmental Awareness	
	Data Development and Implementation	
	5. Big Data Analytics	
	Project and Process Management	
	6. Plant Turnaround	7. Project Management
	Green Manufacturing Practice	
	8. Sustainable Manufacturing	9. Eco-Design Principles
	Technology Management	
	10. Robotic and Automation Technology	
	General Management	
	11. Resource Management	

Skills Category	Skills Clusters	
List of skills relevant to Chemical sector (non-exhaustive)	1. Continuous Improvement	7. Crisis and Disaster Recovery Management
	2. Preventive Maintenance	8. Asset Integrity Management
	3. Materials Specification	9. Maintenance Integrity and Reliability
	4. Incident Investigation	10. Plant Turnaround
	5. Major Hazard Installation Safety Case Management	
	6. Process Safety Management	

Role and Skills Analysis by Impact Level

The impact study for the Chemical sector identified 59 critical roles: 51 established roles essential for maintaining industry standards and operational efficiency, and eight (8) emerging roles that are set to drive future advancements and innovations.

Impact Assessment on 51 Existing Roles in the Chemical Sector

	High	Medium	Low	Emerging
AI/Digital	• **High opportunity** to **automate** • **Low human intervention**	• **High opportunity** to **automate** • **High human intervention**	• **Low opportunity** to **automate** • **High or low human intervention**	
Green Economy	• **Job no longer required** due to impact to environment • **May or may not** have **opportunity to diversify**	• **Job still required** despite impact to environment • **Opportunity to diversify exist**	• **Job still required** despite impact to environment • **No opportunity to diversify**	New job positions created due to technological advancements, sector trends, and societal changes help organisations drive innovation, adopt sustainable practices, and stay competitive and compliant with evolving regulations and market demands.
Outcome	**Roles facing convergence or displacement** Need to pivot to adjacent role and reskill	**Roles are evolving** Need to upskill to deliver beyond what would traditionally be expected	**Roles not severely impacted** Need to continue improving to keep self relevant	
	10 Roles	28 Roles	13 Roles	8 Roles
Proportion of Roles	20%	55%	25%	

The impact study focuses on assessing the roles significantly impacted by the growth of AI, Digital, and Green Economy. Its primary objective is to ascertain viable career pathways and the essential skills required for the Malaysian workforce while emphasising the emergence of roles driven by these trends that can enhance the sector's competitive advantage.

Below is an overview of the impact assessment on 51 existing roles across the Chemical sector, with 10 highly impacted roles, 28 medium impacted roles, 13 low impacted roles, and eight (8) emerging roles.

An Overview of the Impact Assessment on 51 Existing Roles across the Chemical sector

HIGH

10 Roles

1. HSE Executive / Assistant
2. Process Engineer
3. Production Planner
4. Laboratory Analyst
5. R&D Assistant / Laboratory Technician
6. Weighbridge Supervisor
7. Weighbridge Operator
8. Warehouse Storekeeper / Inventory Coordinator
9. Forklift Operator
10. Occupational / Industrial Hygiene Officer

MEDIUM

28 Roles

1. Maintenance Planner
2. HSE Manager
3. Production Manager
4. Process Safety
5. Production Supervisor / Superintendent
6. General Manager / Director Production
7. Laboratory Chemist
8. Laboratory Supervisor
9. R&D Chemist
10. Application Chemist
11. Senior Technical Service Engineer
12. Technical Service Engineer
13. Technical Service Manager
14. Production Technician
15. Production Senior Manager
16. Warehouse / Inventory Manager
17. Warehouse / Inventory Executive
18. Project Engineer
19. Environment Officer
20. Maintenance (Mechanical) Engineer / Senior Engineer
21. Maintenance (Instruments) Manager
22. Maintenance (Instruments) Engineer / Senior Engineer
23. Maintenance (Instruments) Technician
24. Maintenance (Civil & Structural) Engineer / Senior Engineer
25. Maintenance (Civil & Structural) Technician
26. Maintenance (Material, Corrosion & Inspection) Engineer / Senior Engineer
27. Maintenance (Material, Corrosion & Inspection) Technician
28. Materials Coordinator

LOW

13 Roles

1. Construction Engineer
2. General Manager / Director / Chief Engineer
3. QA Engineer
4. QA & QC Manager
5. R&D Manager
6. General Manager / Director Health, Safety and Environment (HSE)
7. Maintenance (Mechanical) Manager
8. Maintenance (Mechanical) Technician
9. Maintenance (Electrical) Manager
10. Maintenance (Electrical) Engineer / Senior Engineer
11. Maintenance (Electrical) Technician
12. Maintenance (Civil & Structural) Manager
13. Maintenance (Material, Corrosion & Inspection) Manager

EMERGING

8 Roles

1. Data Analyst
2. Data Engineer
3. Data Scientist
4. Sustainability Specialist
5. Integrated Engineer / Inter-disciplinary Engineer
6. Advanced Materials Scientist
7. Digital Project Manager
8. Robotics Engineer

Highly Impacted Roles and Career Pathways

Discussions with industry players have highlighted 10 highly impacted roles distributed across several key clusters: Logistic and Warehousing (4), Production (2), HSE (2), QA & QC (1), and R&D (1).

With the swift progress in AI and digitalisation, critical roles in the Chemical sector are increasingly focused on leveraging data-driven insights, advanced analytics, and automation. This shift is driving a fundamental transformation in how operations are managed, enabling companies to optimise processes, reduce costs, and enhance product development. As a result, professionals in these roles are required to develop new competencies in AI technologies, digital tools, and data interpretation, positioning them at the forefront of innovation and efficiency in a highly competitive market.

Additionally, these professionals have the opportunity to transition into various roles both within and outside the Chemical sector. For instance, a Production Planner may shift to positions in logistics within or into other sectors doing similar roles or different roles. However, it's important to consider that moving from a Production Planner to a Supply / Demand Planner role may not be a long-term solution, as advancements in automation could affect the future viability of the Supply/Demand Planner role.

Case Studies for Highly Impacted Roles

AI is revolutionising industries by automating routine tasks, freeing up professionals to focus on strategic decision-making and innovation. This transformation necessitates professionals to acquire new skills in AI integration, data interpretation, and advanced analytics to collaborate effectively with AI systems, ensuring continuous improvement while maintaining regulatory standards.

Roles	Impact and Case Studies
Production Planner	**BASF** is heavily investing in digital tools to streamline their supply chain operations. This includes the use of AI and other digital platforms to improve logistics visibility, integrate supply chains, and provide better insight into the performance of their operations. These efforts are geared toward creating a more transparent and efficient supply chain. They are also exploring AR technologies to support real-time monitoring and management within their supply chain operations. AR applications are designed to provide employees with instant access to necessary information, enhancing process efficiency and decision-making.[17]
Warehouse Storekeeper / Inventory Coordinator	The adoption of advanced technologies in chemical warehousing facilities involves deploying robotic systems for handling and storage, integrating IoT and AI for real-time data analysis, and implementing advanced Warehouse Management System (WMS) for better inventory control. This shift from manual to automated processes is designed to enhance safety, reduce errors, and lower operational costs.[18]
Lab Technician / Assistant	**Toray Plastics (Malaysia) Sdn Bhd** uses digital tools in monitoring production processes, which suggests that Lab Analysts could transition into roles such as Lab Supervisor or Production Technician, where they would apply their analytical skills to manage and optimise production quality. Digitalisation is transforming **BASF's** R&D efforts by enhancing data management, boosting efficiency, and driving innovation. Through the use of advanced technologies like AI, machine learning, and data analytics, the company is streamlining R&D processes, improving productivity, and optimising experimental design. Digital tools also facilitate better collaboration within teams and with external partners, enabling faster and more informed decision-making.[19]
HSE Executive / Assistant	The integration of automation and AI in hazardous environments has significantly improved work safety. **BASF** has successfully merged HSE roles with broader operational management, ensuring that safety is an integral part of their operational strategy, emphasising comprehensive preventive measures and risk management to ensure safe working conditions.[20]
Forklift Operator	**BASF PETRONAS** is gradually introducing automation and digitalisation to complement rather than replace operator roles, particularly in areas like warehousing, where digitalisation is being introduced to automate some of the tasks. This allows operators to focus on more complex and safety-critical tasks, maintaining a significant human role in the process.[21]
Process Engineer	**BASF PETRONAS** is exploring machine learning in their production line. AI-driven machine learning models are being explored to automate decision-making within Distributed Control Systems (DCS) for production. Although this technology is still in the early stages, it holds the potential to significantly optimise production processes by predicting and adjusting to various operational variables in real time.[22]
Weighbridge Supervisor and Weighbridge Operator	From the engagement sessions, local chemical manufacturers have adopted or are adopting automated weighbridge systems that can be controlled from the production control room. These systems use electronic sensors and automated data recording to streamline the weighing of chemical bulk tankers, hence significantly reducing the needs for manual manpower.

17. BASF, Innovative and disruptive technologies for sustainable future success, <https://www.basf.com/global/en/who-we-are/digitalization/artificial-intelligence>
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Highly Impacted Roles Career Pathways

Roles

PROCESS ENGINEER

Key Responsibilities:
Provides technical support on process control and automation to optimise process capability, efficiency, yield, and quality.

Examples of Additional Skills Required and Analysis

AI / DIGITAL SKILLS

1. **Automation System Design:**
The ability to create and implement automated systems provides process engineers with a strong foundation to improve and optimise processes, which is crucial for transitioning into various engineering and operational roles.

2. **Warehouse Automation Application:**
Proficiency in computer software and automated equipment enables process engineers to transition into warehouse-related roles and other operational roles by applying automation principles to enhance performance and efficiency.

3. **Automated Equipment and Control Systems Configuration:**
Process engineers skilled in automation have an advantage when transitioning into more advanced roles. This expertise is essential for optimising systems, minimising downtime, and maximising efficiency.

GREEN SKILLS

1. **Eco-Design Principles:**
This skill enables process engineers to transition into various operational roles by integrating sustainable practices into design and operations, thereby enhancing efficiency and reducing environmental impact across different sectors.

2. **Environmental Awareness:**
This skill equips process engineers with an understanding of environmental regulations and sustainability goals, which is essential for transitioning into roles focused on sustainable production and operations.

Possible Roles for Transition Within the Sector

- Process Safety
- Senior Technical Service Engineer
- Warehouse / Inventory Executive
- Technical Service Engineer
- QA Engineer
- Project Engineer

Possible Roles for Transition into Other Sectors

- **Production Engineer**
  Sector:
  Pharmaceutical Manufacturing
- **Manufacturing Engineer**
  Sector:
  Medical Devices
- **Fuel Systems Operations Engineer**
  Sector:
  Energy and Power

Highly Impacted Roles Career Pathways

(Continue)

Roles

PRODUCTION PLANNER

Key Responsibilities:
Responsible for managing and executing production plans and schedules to ensure that products are delivered to customers on time and within the planned schedule.

Examples of Additional Skills Required and Analysis

AI / DIGITAL SKILLS

1. **Warehouse Automation Application:**
This skill enables production planners to transition into various production and operational roles by optimising processes, managing inventory, and improving efficiency across production schedules, forecasting, and supply chain operations.

2. **Automated Manufacturing Maintenance:**
Proficiency in this skill allows production planners to effectively manage processes, inventory, and operational efficiency, supporting a smooth transition into other planning and production roles.

3. **Advanced Technology Integration:**
This skill equips production planners with the ability to leverage AI and digital technologies, which is essential for optimising operations and enhancing efficiency across other planner roles in various sectors.

GREEN SKILLS

1. **Sustainable Sourcing:**
This skill enables production planners to excel in diverse roles by fostering sustainable supplier partnerships, ensuring that operations align with environmental and ethical standards across various industries.

2. **Eco-Design Principles:**
Proficiency in this skill allows production planners to excel in diverse roles by integrating sustainable practices into production processes, optimising resource use, and reducing environmental impact across industries.

3. **Environmental Awareness:**
This skill prepares production planners to incorporate environmental considerations into planning and operations to ensure compliance with regulations and promote sustainability, which is crucial for advancing in other planning roles.

Possible Roles for Transition Within the Sector

- Maintenance Planner
- Warehouse / Inventory Executive

Possible Roles for Transition into Other Sectors

- **Supervisor / Production Planner Demand Planner / Supply Planner**
  Sector:
  Food Manufacturing and Services
- **Planning Executive / Production Planner**
  Sector:
  Aerospace
- **Production Planner / Demand Planner / Material Planner**
  Sector:
  Medical Devices
- **Coordinator, Logistics & Transport Planner, Merchandise**
  Sector:
  Wholesale and Retail Trade

Highly Impacted Roles Career Pathways

(Continue)

Roles

HSE EXECUTIVE / ASSISTANT

Key Responsibilities:
Implements and administers Workplace Safety and Health (WSH) and Environmental Management System (EMS) programmes, supporting the development of WSH and EMS frameworks in compliance with government regulations and organisational guidelines.

Examples of Additional Skills Required and Analysis

AI / DIGITAL SKILLS

1. **Big Data Analytics:**
This skill enables HSE executives/assistants to transition into other HSE roles by applying advanced data analytics to derive actionable insights from complex datasets, thereby enhancing decision-making and supporting effective health, safety, and environmental strategies.

2. **Data Literacy:**
Proficiency in data literacy allows HSE executives/assistants to effectively analyse, interpret, and communicate data to enhance health, safety, and environmental practices across different industries and work sites.

3. **Automated System Design:**
HSE executives/assistants skilled in automated system design can smoothly transition into other HSE roles by leveraging their expertise to enhance safety and environmental management through the implementation of efficient, functional automated systems.

GREEN SKILLS

1. **Sustainability Management:**
This skill enables HSE executives/assistants to develop and implement sustainability strategies, optimise resource use, and track environmental impact, thereby supporting their transition into other HSE roles.

2. **Waste Disposal Management:**
Expertise in this skill prepares HSE executives/assistants to oversee and optimise waste handling processes, ensuring safe and compliant waste disposal, which is crucial for transitioning into other HSE roles that require managing waste logistics and operations.

3. **Waste Treatment Management:**
Proficiency in this skill allows HSE executives/assistants to effectively manage and plan waste treatment processes, ensuring both safety and environmental compliance, which is crucial for transitioning into HSE roles that involve waste treatment and resource management.

Possible Roles for Transition Within the Sector

Environment Officer

Possible Roles for Transition into Other Sectors

Health, Safety, and Environment Executive
Sector:
Pharmaceutical Manufacturing

Environmental, Health, and Safety (EHS) Engineer
Sector:
Electrical and Electronics

Health, Safety, and Environment Engineer
Workplace Safety Health / HSE Engineer
Sector:
Energy and Power

Highly Impacted Roles Career Pathways

(Continue)

Roles

OCCUPATIONAL / INDUSTRIAL HYGIENE OFFICER

Key Responsibilities:
Responsible for identifying and assessing workplace and work process risks, advising on and recommending measures to eliminate, minimise, or control these risks.

Examples of Additional Skills Required and Analysis

AI / DIGITAL SKILLS

1. **Big Data Analytics:**
Proficiency in this skill allows occupational/industrial hygiene officers to transition smoothly into other HSE roles that require managing complex datasets and improving operational efficiency.

2. **Digital and AI Fluency:**
This skill equips officers to effectively utilise digital tools and AI technologies, streamlining problem-solving and boosting efficiency, which is essential for transitioning into other HSE roles involving advanced technological solutions and digital transformation.

3. **Data Literacy:**
Strong data literacy enables officers to effectively explore, interpret, and communicate data, facilitating informed decision-making and enhancing their ability to manage and report on data-driven environmental and safety metrics across various HSE roles.

GREEN SKILLS

1. **Environmental Remediation:**
This skill enables officers to manage and execute processes for cleaning up and mitigating environmental damage, which is crucial for roles focused on managing pollution, contamination, and restoration across different sectors.

2. **Sustainable Manufacturing:**
Expertise in this skill prepares officers to ensure that production processes are environmentally friendly and resource-efficient, supporting roles that require oversight of sustainable practices and lifecycle management in manufacturing contexts.

3. **Sustainable Business Practices:**
Officers with this skill have an advantage when transitioning into roles focused on implementing sustainability strategies.

Possible Roles for Transition Within the Sector

Environment Officer

Possible Roles for Transition into Other Sectors

Health, Safety, and Environment Executive
Sector:
Pharmaceutical Manufacturing

Environmental, Health, and Safety (EHS) Engineer
Sector:
Electrical and Electronics

Health, Safety, and Environment Engineer
Workplace Safety Health/ HSE Engineer
Sector:
Energy and Power

Environment, Health, and Safety Manager
Sector:
Medical Devices

Highly Impacted Roles Career Pathways

(Continue)

Roles

WEIGHBRIDGE SUPERVISOR

Key Responsibilities:
Oversees the daily operations of the weighbridge, ensuring accurate weighing of all chemical bulk tankers and vehicles. This role involves supervising staff, managing documentation, troubleshooting operational issues, and maintaining safety standards.

Examples of Additional Skills Required and Analysis

AI / DIGITAL SKILLS

1. **Data Modelling and Design:**
   This skill enables weighbridge supervisors to effectively organise and optimise data systems, supporting their transition into executive roles focused on enhancing data management and retrieval efficiency.

2. **Data Mining:**
   Expertise in data mining allows weighbridge supervisors to analyse large datasets for patterns and trends, aiding their transition into executive and planning roles by improving forecasting and decision-making capabilities.

GREEN SKILLS

1. **Renewable Energy:**
   Proficiency in renewable energy prepares weighbridge supervisors to manage energy systems sustainably, which is beneficial when moving into roles that promote energy efficiency and sustainable practices.

2. **Sustainable Manufacturing:**
   This skill allows weighbridge supervisors to transition into roles focused on minimising environmental impact and optimising resource use.

3. **Sustainable Sourcing:**
   This skill is essential for managing responsible supplier relationships, providing weighbridge supervisors with an advantage when transitioning into roles involved in ethical and resource-conserving supply chain practices.

Possible Roles for Transition Within the Sector

Warehouse / Inventory Executive

Possible Roles for Transition into Other Sectors

Transportation Executive
Warehouse / Inventory Executive
Sector:
Food Manufacturing and Services

Executive, Retail Virtual Warehouse Planner, Merchandise
Sector:
Wholesale and Retail Trade

Highly Impacted Roles Career Pathways

(Continue)

Roles

WEIGHBRIDGE OPERATOR

Key Responsibilities:
Responsible for handling the weighing operations for all chemical bulk tankers and vehicles. This includes directing incoming traffic, recording weights, completing documentation, troubleshooting operational issues, and proposing process improvements.

Examples of Additional Skills Required and Analysis

AI / DIGITAL SKILLS

1. **Data Mining:**
This skill enables weighbridge operators to analyse large datasets to uncover patterns and trends, facilitating their transition into coordinator roles that require data-driven forecasting and decision-making.

2. **Big Data Analytics:**
Expertise in this skill allows weighbridge operators to process and interpret complex datasets, aiding their transition into roles that involve generating insights for improved inventory management and operational efficiency.

3. **Robotic and Automation Technology:**
This skill prepares weighbridge operators to transition into roles where integrating advanced systems is essential for enhancing productivity and precision in areas such as manufacturing and logistics.

GREEN SKILLS

1. **Sustainable Transportation Management:**
This skill enables weighbridge operators to optimise transportation routes and select eco-friendly vehicles, which is beneficial for roles focused on reducing environmental impact and improving efficiency.

2. **Sustainable Business Practices:**
Proficiency in this skill supports weighbridge operators in executing strategies that balance environmental, social, and economic considerations, aiding their transition into roles focused on responsible operational practices.

3. **Sustainable Manufacturing:**
Expertise in this skill enables weighbridge operators to adopt practices that minimise environmental impacts and optimise resource use, which is advantageous when moving into roles that oversee efficient and eco-friendly operations.

Possible Roles for Transition into Other Sectors

Warehouse Storekeeper / Inventory Coordinator
Sector:
Food Manufacturing and Services

Warehouse Associate / Assistant / Material Handler
Sector:
Medical Devices

Coordinator, Logistics & Transport Assistant, Retail Virtual Warehouse
Sector:
Wholesale and Retail Trade

Highly Impacted Roles Career Pathways

(Continue)

Roles

WAREHOUSE STOREKEEPER / INVENTORY

Key Responsibilities:
Responsible for coordinating general warehouse operations and activities, including shipping and receiving deliveries, conducting stock checks, documenting warehouse transactions and records, and storing inventory.

Examples of Additional Skills Required and Analysis

AI / DIGITAL SKILLS

1. **Digital and AI Fluency:**
This skill helps warehouse storekeepers / inventory coordinators leverage digital tools and AI for enhanced problem-solving and efficiency, facilitating their transition into roles focused on integrating technology for operational efficiency.

2. **Data Modelling and Design:**
Proficiency in this skill allows warehouse storekeepers / inventory coordinators to effectively structure and manage data systems, supporting their transition into roles focused on optimising data storage and retrieval for improved inventory management.

3. **Data Mining:**
This skill is essential for analysing large datasets to identify patterns and trends, which is crucial for transitioning into roles focused on data-driven forecasting and decision-making.

GREEN SKILLS

1. **Environmental Management System:**
This skill enables warehouse storekeepers / inventory coordinators to create frameworks for regulatory compliance and sustainability, facilitating a smooth transition into roles that require expertise in environmental management best practices.

2. **Sustainable Transportation Management:**
Proficiency in this skill allows warehouse storekeepers / inventory coordinators to optimise transportation routes and select eco-friendly vehicles, which is essential for transitioning into roles focused on improving logistics efficiency and reducing environmental impact.

3. **Environmental Remediation:**
The ability to manage and mitigate environmental damage enables warehouse storekeepers / inventory coordinators to transition into roles that focus on applying environmental remediation techniques to reduce adverse environmental effects.

Possible Roles for Transition Within the Sector

Material Coordinator

Possible Roles for Transition into Other Sectors

Warehouse Storekeeper / Inventory Coordinator
Sector:
Food Manufacturing and Services

Coordinator, Logistics & Transport Assistant, Retail Virtual Warehouse
Sector:
Wholesale and Retail Trade

Warehouse Associate / Assistant / Material Handler
Sector:
Medical Devices

Highly Impacted Roles Career Pathways

(Continue)

Roles

FORKLIFT OPERATOR

Key Responsibilities:
Responsible for sorting, routing, and loading cargo to and from various warehousing or storage locations.

Examples of Additional Skills Required and Analysis

AI / DIGITAL SKILLS

1. **Data Modelling and Design:**
This skill enables forklift operators to improve data management and system organisation, aiding their transition into roles focused on enhancing data storage and retrieval processes.

2. **Data Mining:**
This skill allows forklift operators to uncover patterns and trends in datasets, supporting their move into roles requiring data-driven forecasting.

3. **Big Data Analytics:**
Expertise in this skill helps forklift operators analyse and interpret complex datasets, giving them an advantage when transitioning into roles that leverage data-driven insights to enhance operational efficiency.

GREEN SKILLS

1. **Sustainable Transportation Management:**
This skill allows forklift operators to manage transportation processes with a focus on reducing environmental impact, which is essential for transitioning into roles focused on optimising routes and selecting eco-friendly solutions.

2. **Sustainable Business Practices:**
The ability to execute strategies that balance environmental, social, and economic goals facilitates the transition of forklift operators into roles that integrate sustainability into daily operations.

3. **Sustainable Manufacturing:**
Proficiency in this skill enables forklift operators to apply practices that minimise environmental impact and optimise resource use, allowing them to transition into roles focused on sustainable production processes.

Possible Roles for Transition into Other Sectors

Forklift Operator
Warehouse Storekeeper / Inventory Coordinator
Sector:
Food Manufacturing and Services

Warehouse Associate / Assistant / Material Handler
Sector:
Medical Devices

Coordinator, Logistics & Transport Assistant, Retail Virtual Warehouse
Sector:
Wholesale and Retail Trade

Highly Impacted Roles Career Pathways

(Continue)

Roles

R&D ASSISTANT / LABORATORY TECHNICIAN

Key Responsibilities:
Supports R&D by researching and compiling data, conducting tests, maintaining lab equipment, documenting experimental data, and ensuring compliance with Good Laboratory Practices, while collaborating effectively within a team.

Examples of Additional Skills Required and Analysis

AI / DIGITAL SKILLS

1. **Big Data Analytics:**
   This skill equips R&D assistants / laboratory technicians with the ability to analyse complex datasets to generate actionable insights, supporting their transition into roles that require data-driven decision-making and process optimisation.

2. **Active and Smart Packaging:**
   Proficiency in this skill enables R&D assistants / laboratory technicians to implement innovative packaging solutions that improve product shelf life and safety, facilitating their move into roles focused on advancing product development and quality assurance.

3. **Advanced Processing Technology:**
   Expertise in this skill allows R&D assistants / laboratory technicians to design and manufacture food products with enhanced quality and shelf life, aiding their transition into roles that apply advanced processing techniques to ensure product excellence.

GREEN SKILLS

1. **Green Manufacturing Design and Implementation:**
   The ability to contribute to sustainable manufacturing processes helps R&D assistants / laboratory technicians transition into roles that integrate waste reduction and energy conservation practices into processes such as quality control and assurance.

Possible Roles for Transition into Other Sectors

Quality Control Laboratory Analyst
Quality Control Assistant Laboratory Analyst
Sector:
Pharmaceutical Manufacturing

Quality Assurance and Quality Control Supervisor / Executive / Laboratory Supervisor
Sector:
Food Manufacturing and Services

R&D Assistant
Sector:
Food Manufacturing and Services

Highly Impacted Roles Career Pathways

(Continue)

Roles	Examples of Additional Skills Required and Analysis		Possible Roles for Transition into Other Sectors
	AI / DIGITAL SKILLS	GREEN SKILLS	
LABORATORY ANALYST **Key Responsibilities:** Carries out daily laboratory tasks, including basic calibration and simple troubleshooting of laboratory equipment and online analysing devices, and checks laboratory consumable inventory.	1. **Active and Smart Packaging:** This skill enables laboratory analysts to apply innovative packaging solutions that improve product shelf life and safety, aiding their transition into roles focused on advancing product development and quality control. 2. **Advanced Processing Technology:** Expertise in this skill equips laboratory analysts to design and manufacture high-quality, nutritious food products, facilitating their move into roles that integrate technology to ensure excellent product quality.	1. **Green Manufacturing Design and Implementation:** Expertise in this skill helps laboratory analysts contribute to sustainable practices by focusing on waste reduction and energy conservation, facilitating their transition into roles that integrate environmentally friendly practices into processes.	**Quality Control Laboratory Analyst** **Quality Control Assistant Laboratory Analyst** Sector: Pharmaceutical Manufacturing **Quality Assurance and Quality Control Supervisor / Executive / Laboratory Supervisor** Sector: Food Manufacturing and Services **R&D Assistant** Sector: Food Manufacturing and Services

Projected Number of Highly Impacted Employees

According to the TalentCorp Demand Model Projection,[23] approximately 18,000 employees or 20% will be at risk in the next three (3) to five (5) years due to highly impacted roles.

Summary of Highly Impacted Roles

Production	Logistics and Warehousing	Health, Safety, and Environment	R&D	Quality Control and Quality Assurance
• Process Engineer • Process Planner	• Weighbridge Supervisor • Weighbridge Operator • Warehouse Storekeeper / Inventory Coordinator • Forklift Operator	• HSE Executive / Assistant • Occupational / Industrial Hygiene Officer	• R&D Assistant / Laboratory Technician	• Laboratory Analyst

Findings

Based on the TalentCorp Demand Model Projection, the workforce in the Chemical core business is expected to reach approximately **150,000 by 2029**. It is estimated that around **20%** of these employees—approximately **18,000**—may face job risks within the next **three (3) to five (5) years**, due to roles being significantly affected, according to assessments by industry experts.

In summary, industry players acknowledge that the integration of AI, Digital, and green strategies is essential for achieving sustainable growth and maintaining competitiveness. Businesses are investing in a comprehensive operational shift, spanning from production line to logistic and warehousing functions within the manufacturing setting.

- With the rise of digitalisation and automation in the production line as well as production monitoring and quality controls, more of the routine tasks can now be automated; industry players indicated that roles such as **Process Engineer, Production Planner, Laboratory Analyst and HSE Executive / Assistant** will be highly impacted which potentially require reskilling.
- Industry players are also increasingly digitalising their Logistic and Warehousing operations which employs technological advancement such as automated weighbridge operations, robotic arms in warehouse, and streamlined supply chain systems to enhance efficiency, safety and consistency, causing job reductions and impacting roles such as **Weighbridge Supervisor, Weighbridge Operator, Warehouse Storekeeper / Inventory Coordinator, and Forklift Operator**.

Consequently, this is leading to a reduction in headcount across all roles identified as highly impacted which could experience a projected workforce impact of up to 12% in the organisation,[24] may be redefined to concentrate on more value-added roles. Employers with these roles in their organisation will need to plan for talent reskilling and pivoting strategies within or across sectors.

23. Department of Statistics Malaysia; TalentCorp Demand Model Projection
24. mpact Study Industry Survey

Medium and Low Impacted Roles

Medium Impacted Roles Analysis

Medium impacted roles mainly revolve around using technology to enhance content production and delivery. As businesses shift towards a customer-centric model, developing skills to better understand customer preferences is becoming increasingly important.

Industry players are beginning to leverage AI to optimise manufacturing processes, predictive maintenance, and quality control. This adoption of AI leads to increased efficiency, reduced downtime, and improved product quality. Embracing digital transformation by integrating IoT, cloud computing, and advanced data analytics into operations allows for real-time monitoring, better decision-making, and enhanced operational efficiency.

Also, ensuring compliance with local and international environmental regulations and pursuing certifications such as ISO 14001 for environmental management not only enhances sustainability but also improves market competitiveness and reputation.

Job Clusters	Medium Impacted Roles	Skills
Engineering and Maintenance	• Maintenance (Mechanical) Engineer / Senior Engineer • Maintenance (Instruments) Manager • Maintenance (Instruments) Engineer / Senior Engineer • Maintenance (Instruments) Technician • Maintenance (Civil & Structural) Engineer / Senior Engineer • Maintenance (Civil & Structural) Technician • Maintenance (Material, Corrosion and Inspection) Engineer / Senior Engineer • Maintenance (Material, Corrosion and Inspection) Technician • Maintenance Planner • Project Engineer	**Specific Skills** • Continuous Improvement • Resource Management • WSH Framework and Practices • Data Integration • Plant Turnaround **Additional Skills** • Robotic Automation Technology • Robotic and Automation System • Data Integration • Data Analytics System Design • Eco-Design Principles

Job Clusters	Medium Impacted Roles	Skills
Health, Safety, and Environment	• HSE Manager • Environment Officer • Process Safety	**Specific Skills** • Cleaning Chemical Handling • Environmental Management System • Waste Disposal Management • Waste Treatment Management • Engineering Safety Standards **Additional Skills** • Automation Design • Data and Statistical Analysis • Robotic Automation Technology • Sustainable Business Practices • Eco-Design Principles
Logistics and Warehousing	• Warehouse / Inventory Manager • Warehouse / Inventory Executive • Materials Coordinator	**Specific Skills** • Customer Orientation • Cross Docking • Warehouse Administration • Dangerous Good Management • Inventory Control Management **Additional Skills** • Automation Design • Automated Manufacturing Maintenance • Data and Statistical Analysis • Warehouse Automation Application • Eco-Design Principles
Production	• Production Senior Manager • Production Manager • Production Supervisor / Superintendent • Production Technician	**Specific Skills** • Process Optimisation • Engineering Drawing Interpretation • Process Plant and Equipment Integrity • Feedstock and Product Transfer Operations • Procurement Management **Additional Skills** • Robotic Automation Technology • Data Analytics System Design • Data and Statistical Analysis • Sustainable Business Practices • Eco-Design Principles
Quality Assurance & Quality Control	• Laboratory Chemist • Laboratory Supervisor	**Specific Skills** • Quality Assurance Management • Laboratory Operations • Sample Management • Product Testing • Laboratory Data Reporting and Analysis **Additional Skills** • Data and Statistical Analysis • Sustainable Business Practices • Eco-Design Principles
Research and Development	• R&D Chemist	**Specific Skills** • Research and Development Management • Materials Specification • Organisational Management • Product Design and Development • Laboratory Operations **Additional Skills** • Data and Statistical Analysis • Advanced Technology Integration • Sustainable Business Practices • Sustainable Landscapes
Site Management	• General Manager / Director Production	**Specific Skills** • Engineering Support • Engineering Safety Standards • Reliability Engineering • Equipment and System Value Engineering • Asset Integrity Management **Additional Skills** • Robotic Automation Technology • Data Analytics System Design • Data and Statistical Analysis • Sustainable Business Practices • Eco-Design Principles

Job Clusters	Medium Impacted Roles	Skills
Technical Service and Applications	• Application Chemist • Senior Technical Service Engineer • Technical Service Engineer • Technical Service Manager	**Specific Skills** • Business Planning • Project Coordination and Management • Product Design and Development • Strategy Development and Service Excellence • Quality Control Management **Additional Skills** • Advanced Technology Integration • Data and Statistical Analysis • Sustainable Business Practices • Sustainable Landscapes

Low Impacted Roles

Roles with low impacted are the least affected by technological shifts and require high levels of creativity, judgement, and interaction. However, as industries evolve, skills that leverage technology and drive sustainability will increasingly become crucial for future roles.

Industry players should actively participate in industry-specific sustainability initiatives and forums. These platforms offer opportunities to share best practices, collaborate on sustainability research, and advocate for regulatory policies that support green manufacturing practices. Embracing transparent reporting mechanisms is also vital. This includes communicating environmental performance metrics, sustainability goals, and progress to stakeholders, fostering trust and accountability.

Roles	Skills
Engineering and Maintenance • Construction Engineer • Maintenance (Mechanical) Manager • Maintenance (Mechanical) Technician • Maintenance (Electrical) Manager • Maintenance (Electrical) Engineer / Senior Engineer • Maintenance (Electrical) Technician • Maintenance (Civil & Structural) Manager • Maintenance (Material, Corrosion & Inspection) Manager **Quality Assurance and Quality Control** • QA Engineer • QA & QC Manager **Research and Development** • R&D Manager **Site Management** • General Manager / Director / Chief Engineer • General Manager / Director Health, Safety, and Environment (HSE)	**Specific Skills** • Business Planning and Strategy Development • Project Coordination and Development • Risk Management • Resource Management • Stakeholder Management • Quality Assurance and Control Management • Process Improvement and Optimisation • Data and Statistical Analysis • Technology Integration and Management • Staff and Organisation Management • Compliance and Audit Management • Crisis and Disaster Recovery Management • Environmental and Safety Management • Financial Management **Basic Skills** • Learning Agility • Digital and AI Fluency • Critical Thinking • Innovative Thinking • Sustainability Awareness • Adaptability and Resiliency • Communication • Empathy • Teamwork and Collaboration • Cognitive Skills

AI / DIGITAL SKILLS

1. **Advanced Technology Integration**
   Essential for managerial roles to implement AI / Digital initiatives into business operations.
2. **Digital Business Model Innovation**
   Managerial roles should take a hands-on approach in identifying potential opportunities to transform existing business models.

GREEN SKILLS

1. **Sustainable Business Strategies**
   Managerial roles should incorporate Sustainability strategies that meet green criteria to ensure long-term environmental and economic benefits.
2. **Sustainable Manufacturing**
   Reduce environmental impact includes producing goods with processes that minimises negative environmental impact, is economically viable and socially responsible throughout the entire product lifecycle.

Projected Numbers of Medium and Low Impacted Employees

Approximately 140,000, or 80%, of medium and low impacted employees require upskilling related to AI, Digital, and Green Economy.[25]

Based on assessment and sector feedback, a total of 141 basic and specific skills were identified for the Chemical sector, in which 12% are AI or Digital skills, and 6% are Green skills. For roles classified as medium impacted roles to progress and perform beyond traditional expectations, it is important that at least 55% of these roles are upskilled. While upskilling is not mandatory for the 25% of roles designated as low impacted roles, continuous self-improvement is advised to maintain relevance and make informed decisions, particularly to keep up with the knowledge of emerging trends.

In-Demand Skills for AI, Digital, and Green Economy

Training Programmes Available

AI / Digital Skills

AI / Digital skills that are essential for roles to adopt for business operations enhancements and overall workforce productivity improvements

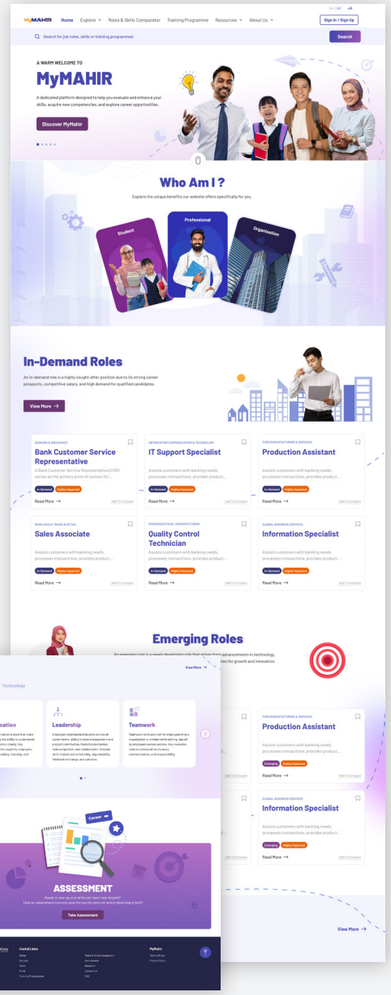
- Digital and AI Fluency
- Big Data Analytics
- Robotic and Automation Technology
- Technology Infrastructure Management and Integration
- Robotic and Automation System
- Automated Manufacturing Maintenance
- Systems Integration
- Instrumentation, Control Field, and System Maintenance

Green Skills

Green skills that are needed for roles to integrate sustainability efforts and initiatives into business operations

- Sustainability Awareness
- Sustainability Manufacturing
- Eco-Design Principles
- Environmental Awareness
- Waste Treatment Management
- Waste Disposal Management
- Environmental Remediation
- Environmental Management System

List of proposed training programmes is accessible on the **MyMAHIR platform**.



25. Department of Statistics Malaysia; TalentCorp Demand Model Projection

Emerging Roles

Global Presence of Emerging Roles in the Chemical Sector

Emerging roles such as Data Analyst, Sustainability Specialist, Integrated Engineer / Inter-disciplinary Engineer, and Advanced Materials Specialist are becoming increasingly prominent in the Chemical sector globally, including in countries like the US, United Kingdom (UK), Germany, China, and India.

1. **BASF** uses data analytics to monitor and optimise its chemical production processes. By analysing real-time data from sensors and equipment, they can make adjustments to improve efficiency, reduce energy consumption, and minimise waste. This approach has led to significant cost savings and enhanced production performance.

2. **AkzoNobel**, a global leader in paints and coatings, has dedicated Sustainability Specialists who work on reducing the environmental impact of their products and operations. They focus on areas like reducing VOC emissions, improving energy efficiency, and developing sustainable product lines.

3. Process Integration Engineer at **SABIC** works on integrating different chemical processes to create more efficient production systems, with a focus on sustainability and reducing environmental impact.

4. **3M** has developed a wide range of advanced materials, including high-performance adhesives, coatings, and films that are used in sectors ranging from healthcare to electronics. 3M's materials scientists are also heavily involved in developing sustainable materials, such as bio-based adhesives and recyclable materials, to reduce environmental impact.

Demand Projection for Emerging Roles

New job positions are emerging as a result of technological advancements, sector trends, and societal changes, helping organisations drive innovation, adopt sustainable practices, and remain competitive and compliant with evolving regulations and market demands. Essential and specialised skills are identified to prepare professionals for the unique challenges of these roles. As AI, digital technologies, and green practices become increasingly integrated into the sector, these roles and skills will continue to evolve and expand.

From the impact assessment, emerging roles were identified: Data Scientist, Data Analyst, Data Engineer, Sustainability Specialist, Integrated Engineer / Inter-disciplinary Engineer, Advanced Materials Scientist, Digital Project Manager, and Robotic Engineer.

Projected Demand for Emerging Roles for each organisation in the next three (3) to five (5) years

	Multinational Corporations (MNCs)	Government Linked Companies (GLCs)	Public Listed Companies (PLCs)
Data Analyst	1-5	0-1	0-1
Data Engineer	0-3	0-2	0-1
Data Scientist	0-3	0-2	Not Needed
Sustainability Specialist	1-3	0-1	0-2
Integrated Engineer / Inter-disciplinary Engineer	1-10	0-2	Not Needed
Advance Materials Scientist	1-5	0-1	Not Needed
Digital Project Manager	0-2	0-4	Not Needed
Robotic Engineer	0-2	0-2	0-3

Findings[26]

Digital Project Manager and Robotic Engineer

- These roles are emerging within MNCs, GLCs, and PLCs due to the increased integration of digital tools and automation. Digital Project Manager is essential for overseeing the strategic implementation of digital transformation initiatives within the organisation, while Robotics Engineer plays a critical role in designing, developing, and maintaining robotic and automated systems in the organisation.

Data Analyst, Data Engineer and Data Scientist

- Adoption of digital tools and automation leads to the acquisition of massive amounts of data which requires specialised roles to manage and utilise this data effectively. MNCs, GLCs, and PLCs will require these roles to process and interpret large volumes of data, build the infrastructure to allow data collection and storage, as well as leveraging on machine learning and predictive modelling. However, it is also noted from the engagement session that Data Analyst role is an existing role for many of the larger industry players; however, it may be an emerging role for the smaller and medium sized players who may not be as advanced in terms of adopting digital and AI initiatives in their businesses.

Sustainability Specialist and Advanced Materials Scientist

- MNCs, GLCs, and PLCs require Sustainability Specialists to develop and implement sustainability strategies due to stringent sustainability regulations especially on global markets.
- MNCs also require Advanced Materials Scientists as they transition to a circular economy model, which necessitates specialised roles to develop new, sustainable, and high-performance materials to meet global demands while optimising processes to convert chemical waste into reusable chemicals as feedstock.

Integrated Engineer / Inter-disciplinary Engineer

- The role of Integrated Engineer / Inter-disciplinary Engineer is becoming increasingly prominent as the sector adopts more complex technologies and integrates sustainability into its operations. MNCs and GLCs will require this role as they embark on technology transformation, while PLCs may not require it immediately, as they approach the journey in phases.

26. Talentcorp sector survey on Impact Study Validation Workshop

Chapter 5:

Recommended Initiatives

Through the impact study assessment, **nine (9) Recommended Initiatives** have been identified across the talent ecosystem to adapt to AI, Digital, and Green Economy trends within Malaysia's Chemical sector. These plans aim to harness opportunities and address challenges posed by these transformative trends. Aligning with the needs and aspirations of each stakeholder group will foster innovation, promote skill development, and ensure the sustainable growth of the Chemical sector.

As shown in the table below, initiatives are grouped into four (4) stakeholder categories: **Government**, **Industry Players**, **Academia**, and **Training Providers**.

Summary of nine (9) Recommended Initiatives

Government

IN1
Provide **Funding and Incentives** to Encourage Adoption of Emerging Technologies and Practices

IN2
Upgrade **Existing Chemical Parks with Advanced Infrastructure** to Keep Pace with Emerging Digital Technologies and Environmental Regulations

IN3
Attract Foreign Technology Leaders to Malaysia and **Promote New Technologies**

Industry Players

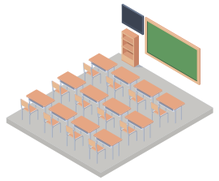
IN4
Introduce **In-House Roadmap** for Adoption of Emerging Technologies

IN5
Encourage **Investment** in Emerging Digital Technologies

IN6
Establish **Community of Practice (COP)** for Sharing of Best Practices

Academia

IN7
Collaborate with Industry Experts to **Integrate Real-World Practices** in Curriculum and Syllabus to Produce **'Ready-to-Work' Graduates**



Training Providers

IN8
Develop Applicable **Training Content** by Building Partnership with Industry Experts

IN9
Enhance **Training Delivery and Effectiveness** by Onboarding More Credible and Certified Training Providers

Government

IN1 Provide Funding and Incentives to Encourage Adoption of Emerging Technologies and Practices

Introducing targeted funding and incentive programmes to stimulate growth and innovation in the Chemical sector, particularly among SMEs. These incentives should address specific challenges faced by industry players, such as access to capital, technology, and infrastructure.

Initiatives	Case Studies
IN1.1 **Develop and introduce a range of financial incentives** such as tax breaks, tax credits, and deductions for R&D expenditures, investments in sustainable technology, or the adoption of Industry 4.0 technologies. **IN1.2** **Offer low-interest loans or loan guarantees** to support capital investments, such as the purchase of new equipment for facility upgrades. **IN1.3** **Provide direct grants or subsidies** for technology upgrades, certification of standards, and market expansion activities. **IN1.4** **Subsidise training programmes for employees** to acquire new skills related to advanced manufacturing, digital technologies, and sustainable practices. **IN1.5** **Simplify regulatory processes for SMEs** in the sector, including faster approval times for permits and certifications. **IN1.6** **Establish or support innovation hubs and incubators** that provide SMEs with access to shared technical expertise, resources, and equipment.	**United States' Advanced Manufacturing Office (AMO) Initiatives for the Chemical sector:**[27] • AMO's initiatives provided grants and financial incentives to chemical companies to adopt emerging technologies that improved energy efficiency, reduced waste, and optimised chemical processes. • The initiatives funded pilot projects to demonstrate the effectiveness of emerging technologies in real-world chemical manufacturing settings, providing proof of concept for broader industry adoption. **Germany's High-Tech Strategy (HTS) and its Impact on the Chemical sector:**[28] • AFIR has embraced AI to facilitate farmers' access to EU funds. This innovative approach marks a significant step forward in leveraging technology to enhance efficiency and accessibility in agricultural financing.

27. US Department of Energy, Summary Report: Advanced Manufacturing Office Sustainable Chemistry in Manufacturing Processes Roundtable, 17 November 2020
28. Bundesministerium für Bildung und Forschung, Federal Government Report on the High-Tech Strategy 2025: The High-Tech Strategy – a successful model for Germany as a strong country of innovation, June 2021

Benefits

- Financial support reduces the cost burden and accelerates the adoption of emerging technologies and practices especially for SMEs.
- It will also encourage the companies to invest in R&D, leading to innovation and the creation of new materials allowing for greater customisation of products to meet consumers' requirements.
- Incentives will help companies to invest in upskilling their workforce to handle new technologies.

IN2 Upgrade Existing Chemical Parks with Advanced Infrastructure to Keep Pace with Emerging Digital Technologies and Environmental Regulations

Creating a conducive environment for the development of chemical parks by investing in infrastructure to ensure companies, especially SMEs, have the necessary facilities and technologies to support high value-added production.

Initiatives	Case Studies
IN2.1 **Perform periodical assessments** on the existing infrastructure to identify and address gaps. **IN2.2** **Encourage public-private partnerships** to leverage private sector's expertise and investment while providing public sector support. **IN2.3** **Develop infrastructure for testing facilities** within the vicinity of the chemical parks. **IN2.4** **Designate chemical parks as special economic zones** with benefits such as reduced tariffs, streamlined customs procedures, and other regulatory reliefs to attract investors.	**Jurong Island integrated Industrial Park:**[29] • Jurong Island brings together numerous chemical companies in a single location. It features shared infrastructure and services, such as utilities, logistics, and waste management systems. • The park employs advanced digital technologies, including process automation, real-time monitoring, and data analytics, to optimise operations and ensure environmental compliance. **BASF's Verbund Site:**[30] • BASF's Verbund site is one of the largest integrated chemical complexes in the world. The concept of Verbund involves the efficient integration of production plants, energy flows, and logistics. • The site uses sophisticated control systems and digital solutions to manage complex production processes and supply chains. • It emphasises circular economy principles, with by-products from one plant serving as raw materials for another, minimising waste, and maximising resource efficiency.

29. EDB Singapore, Sustainable Jurong Island: EDB outlines plans to transform Jurong Island into a sustainability showcase for Energy and Chemicals, 23 November 2021, <https://www.edb.gov.sg/en/about-edb/media-releases-publications/sustainable-jurong-island-edb-outlines-plans-to-transform-jurong-island-into-a-sustainability-showcase-for-energy-and-chemicals.html>
30. BASF, Verbund sites worldwide, <https://www.basf.com/global/en/who-we-are/strategy/verbund/verbund-sites>

Benefits

- Advanced waste management systems, emissions control technologies and safety measures will help the companies to comply with environmental regulations and minimise the risk of accidents and improve sustainability of the operations.
- Integration of new technologies can facilitate R&D activities, leading to the creation of advanced materials and innovation of products and processes.

> **"Industry stakeholders often encounter a variety of platforms and data points spread across different government bodies. In my view, the government can play a pivotal role by spearheading efforts to integrate and streamline these systems into a unified platform. This would not only simplify how industries engage with government agencies, but also ensure a more strategic and efficient use of data in the future."**
>
> ***Vimala Arumugam, Managing Director, BASF (Malaysia) & BASF South East Asia***

IN3 Attract Foreign Technology Leaders to Malaysia and Promote New Technologies

Taking proactive steps to attract foreign technology leaders to Malaysia and promote new technologies through benchmarking exercises and conferences.

Initiatives	Case Studies
IN3.1 **Organise and sponsor international conferences, trade shows, and expos** that focus on the latest technological advancement in the Chemical sector. **IN3.2** **Identify existing chemical parks as dedicated technology hubs or innovation centres** that encourage collaboration between foreign tech companies and local businesses. **IN3.3** **Support benchmarking activities** that allow local companies to compare their processes and performance with leading global firms, as well as international standards and best practices in AI governance, such as the European Union's Ethics Guidelines for Trustworthy AI and adapt them to the Malaysian context. **IN3.4** **Encourage joint R&D projects between foreign tech leaders and Malaysian universities or research institutions** via diplomatic channels and bilateral agreements to lead the development of new technologies and advanced materials suited to local and market needs.	**Singapore's Strategy to Attract Foreign Technology Leaders and Promote New Technologies:** • Singapore Economic Development Board (EDB) offers financial incentives, grants, and tax breaks to attract foreign technology companies.[31] These incentives are designed to make Singapore an appealing destination for tech giants and emerging startups. • The country hosts high-profile international conferences such as the Singapore FinTech Festival,[32] Industrial Transformation ASIA-PACIFIC, and Singapore Week of Innovation and Technology (SWITCH). These events attract global thought leaders, investors, and innovators to share insights, showcase new technologies, and foster collaborations.

31. EDB Singapore, 2023 in Review: Singapore's incentives and schemes for global businesses and local enterprises, 27 December 2023, <https://www.edb.gov.sg/en/business-insights/insights/2023-in-review-singapores-incentives-and-schemes-for-global-businesses-and-local-enterprises.html>
32. Singapore Fintech Festival, The Global Gathering Of Policy, Finance & Technology, <https://www.fintechfestival.sg>

Benefits

- Local companies can adopt new and cutting-edge technologies from foreign tech leaders via technology transfer.
- The presence of foreign technology companies can stimulate economic growth by attracting investments, creating high-value jobs.
- Local companies are able to foster innovative ecosystems, driving R&D, and encourage creation of innovative and advanced materials.
- Promote knowledge sharing and upskilling of local workforce, ensuring the employees are kept abreast with the latest technologies and industry practices.

Industry Players

IN4 Introduce In-House Roadmap for Adoption of Emerging Technologies

Industry players need to develop and implement in-house roadmaps for technological adoption to systematically address challenges. These roadmaps should be strategic, tailored to each company's specific needs, and focused on enhancing competitiveness through innovation and technology.

Initiatives	Case Studies
IN4.1 **Define clear objectives for technological adoption** that align with the company's business strategy and sector's requirement in consideration of national aspirations. **IN4.2** **Adopt a phased approach to technology implementation,** starting with pilot projects in specific areas of the business. This will allow for the assessment of new technologies and the necessary adjustments to maximise their impact. **IN4.3** **Allocate resources for R&D to stay current with developments** and prepare the workforce for a robust talent pipeline. **IN4.4** **Establish a monitoring system** to evaluate the performance and adoption of new technologies, as well as regularly reviewing the roadmap to ensure its relevance.	**Dow Chemical's Integration of Sustainability and Technology:**[33] • Dow has integrated sustainability into its technology adoption roadmap, focusing on reducing its environmental footprint while enhancing production capabilities. • The roadmap includes the adoption of renewable energy sources, the implementation of circular economy principles, and the development of more sustainable products. **BASF's Digital Transformation in Chemical Production:**[34] • BASF has implemented a digital transformation roadmap that includes the digitisation of its entire value chain. • The roadmap involves the use of big data analytics, machine learning, and smart logistics to optimise production processes and supply chains. • BASF has established digital hubs and invested in digital skills training for its employees to support the implementation of the roadmap.

Benefits

- A clear vision, outlining the steps needed to integrate new technologies and helps to ensure all efforts and investments are aligned.
- Provide competitive advantage to the company by remaining relevant to the current market demands and allow for scalable growth as they build on technological capabilities incrementally.
- Allows for structure approach to help identify potential risks and develop mitigation strategy.

33. Dow, Supporting our customers on the Path to Zero emissions, 2023, <https://www.dow.com/content/dam/corp/documents/science-sustainability/066-00454-01-supporting-our-customers-on-the-path-to-zero-emissions.pdf>
34. BASF, The Future of Work is digital, <https://www.basf.com/my/en/careers/professionals/basf_digital_hub_kl>

IN5 Encourage Investment in Emerging Digital Technologies

Industry players should collaborate with technology providers and associations to facilitate the adoption of innovative technologies and tools. This can be achieved by having a pioneer company set a benchmark and demonstrate tangible results, allowing others to observe the benefits before deciding to adopt the technology.

Initiatives	Case Studies
IN5.1 **Establish partnerships with technology providers, startups, and associations** to access cutting-edge solutions and expertise. The association must be able to provide visibility, and facilitate communication among players. **IN5.2** **Identify a cutting-edge technology that has the potential to significantly enhance productivity, efficiency, and sustainability,** providing benefits to multiple players within the sector. **IN5.3** **Run pilot projects with a pioneer company** to test and validate the impact of the technologies before scaling them across the organisation or adopting them by other industry players. **IN5.4** **Organise site visits and live demonstrations** for other industry players, facilitated by the association and host company. **IN5.5** Collaborations allow other companies, especially SMEs to **see the technology in action**, before investing their resources.	**BASF's Partnership with Siemens for Digitalisation in Chemical Production:**[35] • BASF and Siemens collaborated on the digitalisation of chemical production processes using Siemens' 'Process Control System (PCS 7)' and other advanced digital tools. • BASF implemented digital twin technology to create virtual models of its chemical plants. This allows for real-time monitoring, simulation, and optimisation of production processes, leading to more informed decision-making and process improvements. **Dow Chemical's Collaboration with Honeywell for Advanced Automation and Sustainability:**[36] • Dow and Honeywell worked together to implement advanced automation systems and sustainability-focused technologies in Dow's chemical plants focusing on deploying Honeywell's 'Experion® Process Knowledge System (PKS)' to optimise operations and reduce the environmental impact of production processes. • This integration allows for more precise control of chemical processes, enhancing both safety and efficiency.

Benefits

- A culture that embraces digital transformation boosts employee engagement and drives successful technology adoption.
- Structured and manageable integration of new technologies minimises disruptions and optimises resource use.
- A comprehensive assessment helps ensure that the chosen digital tools effectively support operational needs.

35. Siemens, Staying competitive with the Digital Twin, <https://www.siemens.com/global/en/company/stories/industry/2024/basf-chemical-industry-digital-twin-energy-efficiency-decarbonization-germany.html>
36. Market Screener, Dow Chemical : Collaboration between Dow and Honeywell Delivers More Sustainable Appliance Insulation Technology, 28 April 2015, <https://www.marketscreener.com/quote/stock/DOW-CHEMICAL-COMPANY-THE-12332/news/Dow-Chemical-Collaboration-between-Dow-and-Honeywell-Delivers-More-Sustainable-Appliance-Insulatio-20270850/>

IN6 Establish Community of Practice (COP) for Sharing of Best Practices

Forming a group of professionals with a common interest in specific areas to share best practices, particularly in innovation, process improvements, and sustainability practices.

Initiatives	Case Studies
IN6.1 **Drive innovation through collaboration** by initiating regular meetings focusing on specific challenges, and encouraging joint R&D projects to address common problems. **IN6.2** **Organise a conference and/or workshops to share best practices** and its guidelines hence creating a healthy benchmarking platform to measure and compare performance across the sector. **IN6.3** **Establish crisis response protocols** within the COP allowing members to share resources and information quickly during disruptions. **IN6.4** **Facilitate talent development and knowledge transfer** via mentorship and develop standardised training programmes.	**American Chemistry Council (ACC) - Responsible Care® Programme:**[37] • ACC launched the 'Responsible Care® programme', a global initiative designed to improve the safety, health, and environmental performance of the Chemical sector. • The programme includes a 'Community of Practice' (COP) where professionals from member companies share best practices, particularly in innovation, process improvements, and sustainability. **European Chemical Industry Council - Sustainability COP:**[38] • The European Chemical Industry Council has established a 'Community of Practice' focused on sustainability within the Chemical sector. • This COP aims to drive the sector's transition toward a more sustainable future by sharing best practices and fostering collaboration among industry players.

Benefits

- COP allows industry players to collaborate, share insights, and develop innovative solutions faster than they could independently.
- Sharing of best practices allow the industry players to raise the overall quality and safety standards, by avoiding costly mistakes and ensuring compliance.
- It will also combat the issues of talent shortage and talent gaps by nurturing in-house talents, and ensuring continuous supply of skilled workers.

37. American Chemistry Council, Information about Responsible Care®, <https://www.americanchemistry.com/about-acc/membership/information-about-responsible-care>
38. Cefic, The Chemical Industry is a solution provider for Sustainability, <https://cefic.org/a-solution-provider-for-sustainability/>

Academia

IN7 Collaborate with Industry Experts to Integrate Real-World Practices in Curriculum and Syllabus to Produce 'Ready-To-Work' Graduates

A partnership between academia and industry experts will ensure that educational content aligns with current sector standards. This collaboration enhances the relevance of the curriculum, effectively preparing students with the knowledge and skills needed for the workforce.

Initiatives	Case Studies
IN7.1 **Integrating industry guest lecturers, internships with industry players, and projects into the curriculum** will provide students with hands-on experience and direct exposure to the sector. **IN7.2** **Academic institutions and industry experts should collaborate** to co-create and revise course materials, incorporating practical insights, case studies based on relevant skillset. **IN7.3** **Establish advisory boards** consisting of industry experts to provide ongoing guidance and feedback on curriculum design and syllabus content.	**Shell's Collaboration with Delft University of Technology:**[39] • Shell has partnered with Delft University of Technology (TU Delft) in the Netherlands to create a curriculum that integrates real-world industry practices. The goal was to ensure that graduates are equipped with the practical skills and knowledge needed in the chemical and energy sectors. • Shell worked closely with TU Delft to develop a curriculum that includes practical training, research projects, and industry-relevant coursework. The initiative involved Shell providing expertise, resources, and opportunities for students to engage in projects that address real industry challenges.

Benefits

- Students who graduate with real-world experience can transition into the workforce more smoothly.
- Students will gain knowledge of relevant and current material, aligning their education more closely with the needs of the sector.
- Issues of talent shortage and gaps can be addressed, ensuring sufficient talent supply along with the needs of the sector.

39. Christian Jongeneel, How Shell and Delft found each other, TU Delft, October 2019, <https://www.tudelft.nl/en/delft-outlook/articles/how-shell-and-delft-found-each-other/>

Training Providers

IN8 Develop Applicable Training Content by Building Partnership with Industry Experts

Training providers are encouraged to collaborate closely with industry players to develop practical training content tailored to the operational needs of the sector, particularly in-demand AI / Digital and Green skills areas such as data analytics, in order to address existing training gaps.

Initiatives	Case Studies
IN8.1 **Training providers can refer to the in-demand skills analysis** output to identify potential new training courses. **IN8.2** **Training institutions to conduct training gaps analysis** based on current training programmes and refine existing training offerings. **IN8.3** **On an ongoing basis, training providers should ensure their training content is up to date** with the latest technology and sustainability developments. **IN8.4** **Create advisory panels** composed of industry experts, business leaders, and retail associations to provide guidance on curriculum development.	**Society of Chemical Manufacturers & Affiliates (SOCMA) partnership with Owensboro Community & Technical College (OCTC):**[40] • The partnership focuses on providing specialised training programmes tailored to meet the needs of chemical manufacturing sector. • The tools include interactive and hands-on training modules, developed with input from industry experts to address workforce skills gaps. • This collaboration ensures that training remains current with industry standards, helping companies improve their workforce competencies.

Benefits

- The initiative would strengthen teamwork and collaboration between training providers and industry players.
- Greater accessibility and flexibility encourage individuals to learn by providing easy access to high-quality materials and courses at any time.

40. Socma, OCTC Partners with SOCMA to Provide Industry Training Tools, 27 July 2022, <https://www.socma.org/octc-partners-with-socma-to-provide-industry-training-tools/>

IN9 Enhance Training Delivery and Effectiveness by Onboarding More Credible and Certified Training Providers

Training institutions should onboard reputable providers, especially those with expertise in AI, digitalisation, and green practices, as these are highly relevant to the Chemical sector.

Initiatives	Case Studies
IN9.1 **Training institutions to assess credibility and certification status of training providers** to ensure they meet the specific needs and standards of the sector. **IN9.2** **Implement a quality assurance programme** that regularly evaluates the effectiveness of training delivery and content. **IN9.3** **Form partnerships with leading companies and industry experts** in the Chemical sector to enhance the credibility of the training provider. **IN9.4** **Utilise Learning Management Systems (LMS) and other digital platforms** to deliver training content effectively and track learner progress.	**Train the Trainer (TTT) Programme:**[41] • The programme is designed for workplace managers, supervisors, and others in Singapore who are responsible for training, coaching, and assessing employees, while also addressing the organisation's educational needs. • Offered modules include 'Prepare and Conduct Coaching,' which provides the knowledge and skills needed for on-the-job training, and 'Design and Develop Training Curriculum,' which covers identifying training needs and creating in-house training programmes.

Benefits

- Training delivery will stay up-to-date with the latest industry trends and requirements.
- Learners will receive high-quality, industry relevant education including AI/ Digital and Green practices specific to the sector.
- Training delivery will continuously improve, maintaining high standards through regular evaluation and ongoing refinements

41. Institute of Technical Education, Train the Trainer (TTT) Programme, <https://www.ite.edu.sg/courses/part-time-courses/train-the-trainer>

Taking into account the initiatives proposed, moving forward, these are the

Top 5 Initiatives

needed to kickstart the workforce transformation towards AI, Digital, and Green Economy to ensure their successful implementation

1 GOVERNMENT

The Government to introduce targeted funding and incentive programmes to stimulate growth and innovation in the Chemical sector, particularly among SMEs, addressing specific challenges faced by industry players, such as capital, technology, and infrastructure.

2 GOVERNMENT

The Government to create a conducive environment for the development of chemical parks by investing in infrastructure development to ensure companies, especially SMEs, have the necessary facilities and technologies to support high value-added production.

3 INDUSTRY PLAYERS

Industry players to work alongside technology providers and associations in facilitating the adoption of innovative technologies and tools via a pioneer company to set a benchmark and demonstrate tangible results that other industry players can observe before deciding to adopt the technology.

4 INDUSTRY PLAYERS

Establish a group of professionals or COP in a specific area to share best practices especially in the areas of innovation, process improvements, and sustainability practices.

5 ACADEMIA

Academia to partner with industry experts to ensure that educational content is aligned with current standards of the sector. This collaboration enhances the relevance of the curriculum and syllabus, effectively preparing students with the knowledge and skills needed for the workforce.

Conclusion

The Chemical sector is expected to **grow at a steady rate** over the next few years driven by an increased demand for sustainability practices, green energy, the rise of renewable and bio-based materials, geopolitical influences, stricter environmental regulations, and a heightened focus on health and safety. The **global Chemical sector** was valued at USD5.1 trillion (RM22.16 trillion) in 2023 and is estimated to **grow 8.7% to USD7.8 trillion (RM33.9 trillion)** by 2028.

In Malaysia, this growth trend is also well reflected. In 2022, the Chemical sector's contribution to the nation's GDP increased by 4.9% to **RM48.7 billion**, reaching its highest level since 2006. Additionally, exports saw a notable rise of **12.9%**, growing from RM86.7 billion in 2021 to **RM97.9 billion** in 2022. As a fundamental component of numerous industries, the sector's trajectory will be shaped by its ability to adapt to changing demands and leverage emerging opportunities.

As highlighted in this study, advancements particularly in **AI, Digital, and Green Economy will demand significant workforce changes in the Chemical sector**. Professionals skilled in AI technologies will play a crucial role to boost the ability to create novel content, such as synthesising new compounds with specific desired properties. Accelerating the adoption of digital solutions on the other hand, will allow for seamless tracking, risk management and stakeholder engagement processes both in the core products and services offered. Meanwhile, increased investments in innovative sustainability solutions will enable companies to better achieve their sustainable goals, which is an increasingly important area of focus backed by the public sector.

Within the sector, the study projected **10 job roles that face highly impacted** from these trends, with **28 moderately impacted** and **13 minimally impacted**. Additionally, **eight (8) emerging roles** and **21 in-demand skills** were identified to drive future advancements and innovations within the Chemical sector.

The study also identified **nine (9) Recommended Initiatives**, which are designed to ensure a well-equipped workforce capable of meeting industry demands, enhancing competitiveness, promoting sustainable growth, and positioning the Malaysian Chemical sector for significant contributions to national prosperity and global recognition.

Looking ahead, embarking on this journey of continuous adaptation and innovation will be vital in preparing the Chemical sector workforce for ongoing advancements in AI, Digital, and Green Economy. To achieve this, the **MyMAHIR FSTC** will conduct regular needs assessments to identify immediate and future workforce skills gaps, analyse talent demands by sector and educational level, propose strategies, determine essential sector-specific skills, and periodically update these skills in response to technological advancements and evolving operating environments. Additionally, the council will align the educational system with the sector's needs while actively **fostering collaboration among Government, Industry Players, Academia,** and **Training Providers** to enhance Malaysia's competitiveness and **promote sustainable growth** in the Chemical sector.

2023
RM22.16 tri

Estimated to grow 8.7% by 2028
RM33.9 tri

Key trends impacting existing roles:

- Artificial Intelligence
- Digital
- Green Economy

The study identified 10 job roles that will be highly impacted by these trends, along with 8 emerging roles, and 21 in-demand skills essential for future advancements.

MyMAHIR Future Skills Talent Council (FSTC) has been set up to prepare for these changes

Validation Workshop

Validation Workshop


















Abbreviations

ACC	American Chemistry Council
AI	Artificial Intelligence
ALARP	As Low As Reasonably Practicable
AMO	Advanced Manufacturing Office - US
AR	Augmented Reality
C-H	Carbon-Hydrogen
CAGR	Compound Annual Growth Rate
CIR2030	Chemical Industry Roadmap 2030
COP	Community Of Practice
DCoE	Digital Centre Of Excellence
DCS	Distributed Control Systems
EDB	Economic Development Board - Singapore
EHS	Environmental, Health and Safety
ESG	Environment, Social, And Governance
EUR	Euros
EVs	Electric Vehicles
FEED	Front-End Engineering And Design
FSTC	Future Skills Talent Council
GDP	Gross Domestic Product
GHG	Greenhouse Gas
HSE	Health, Safety, and Environment
HTS	High-Tech Strategy - Germany
IAQ	Indoor Air Quality
IR4.0	The Fourth Industrial Revolution
KIPC	Kerteh Integrated Petrochemical Complex
LMS	Learning Management Systems
MHI	Major Hazard Installation
ML	Machine Learning
MyNSR	Malaysia National Skills Registry
NETR	National Energy Transition Roadmap
NIMP 2030	New Industrial Master Plan 2030
OCTC	Owensboro Community & Technical College - US
PCS	Process Control System
PKS	Process Knowledge System
PLC	Public Listed Companies
PSM	Process Safety Management
QA & QC	Quality Assurance And Quality Control
R&D	Research and Development
RDCI	Research, Development, Commercialisation, and Innovation
RM	Ringgit Malaysia
RMKe-12	Twelfth Malaysia Plan
ROI	Return on Investment
SIL	Safety Integrity Levels
SOCMA	Society of Chemical Manufacturers & Affiliates - US
SsoW	Safe System Of Work
SWITCH	Singapore Week Of Innovation and Technology
TNFD	Taskforce On Nature-Related Financial Disclosures
TTT	Train the Trainer Programme - Singapore
TU DELFT	Delft University Of Technology - Netherlands
UK	United Kingdom
USD	US Dollar
VR	Virtual Reality
WSH	Workplace Safety And Health

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IOI Oleochemical Group
Kaneka (Malaysia) Sdn Bhd
Lynas Malaysia Sdn Bhd
Malaysia Petrochemical Association (MPA)
Optimistic Organic Sdn Bhd
PETRONAS Chemical Group (PCG) Berhad
Polyplastics Asia Pacific Sdn Bhd
Sea Hawk Global Lines Sdn Bhd
Sinergi Perdana Sdn Bhd
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