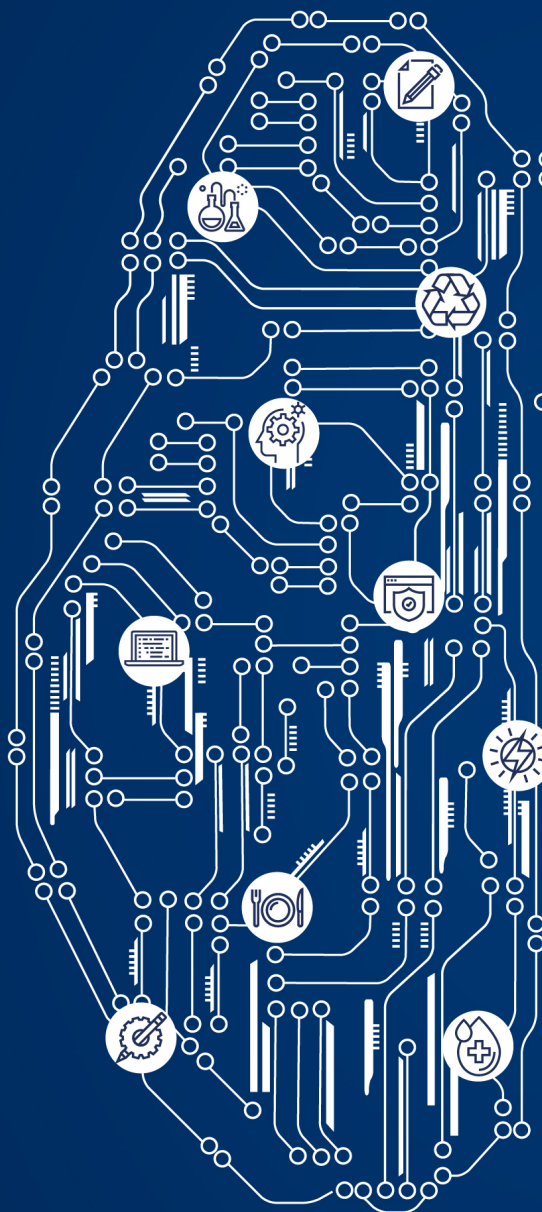




KEMENTERIAN SAINS,  
TEKNOLOGI DAN INOVASI  
MINISTRY OF SCIENCE, TECHNOLOGY AND INNOVATION

**MIGHT**

Malaysian Industry-Government Group  
for High Technology



# FUTURE OF STEM TALENT IN MALAYSIA

## A DELPHI APPROACH

STI Foresight Report  
**2025 - 2040**



# **FUTURE OF STEM TALENT IN MALAYSIA**

**A DELPHI APPROACH**

STI FORESIGHT REPORT  
**2025 - 2040**

## COVER RATIONALE



The cover design of the STI Foresight Report 2025 2040: Future of STEM Talent in Malaysia, A Delphi Approach reflects Malaysia's ambition to build a future ready nation by investing in the talents of its people. The central visual is a stylised brain drawn as an electronic circuit board. This symbolises how human talent powers ideas, innovation and decision making in the same way that a brain controls and energises the body. It underlines the message that nurturing STEM talent is fundamental to powering Malaysia's future development.

The network of lines and circuit-like pathways represents the mapping of STEM skills carried out in this study. The dense connections illustrate how technology push and demand pull interact, and how emerging skills are increasingly interconnected and convergent rather than existing in separate boxes. The branching lines suggest learning journeys that move from education into industry and across sectors, reflecting lifelong learning and mobility of talent.

The ten icons embedded within the brain correspond to the ten prioritised STEM skills identified for the future of STEM talent in Malaysia. Each icon is placed as a node within the circuitry to show that every skill is both distinct and part of a larger, integrated ecosystem. This mirrors the Delphi approach used in the study, where many expert views are connected to form a shared set of priorities.

## REPORT BROUGHT TO YOU BY



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### **Ministry of Science, Technology and Innovation (MOSTI)**

Level 4, Block C5, Complex C,  
Federal Government Administrative Centre,  
62662 Putrajaya, Malaysia

+603-8885 8000  
www.mosti.gov.my

# **MIGHT**

*Malaysian Industry-Government Group  
for High Technology*

Malaysian Industry-Government Group for High Technology  
(MIGHT), 2025

### **Malaysian Industry-Government Group for High Technology (MIGHT)**

MIGHT Partnership Hub,  
Jalan Impact,  
63000 Cyberjaya, Selangor, Malaysia

+603-8315 7928  
www.might.org.my

## STRATEGIC PARTNER

**한국과학기술기획평가원**  
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## ADVISOR

---

Ts. Rushdi Abdul Rahim  
Shahrizal Shahrudin  
Mohd Nurul Azammi Mohd Nudri  
Dr Hyun Yim

## MIGHT

---

Dr Tan Shu Ying  
Shaneeta Visuvanathan  
Norsam Tasli Mohd Razali  
Nur Zulaikha Mohamad Zaki  
Safiyah Mohd Salleh  
Ummu Nadiyah Mohd Yassin  
Dr Mohd Nazreen Mohd Nasir  
Fatini Zulaikha Alias  
Siti Halimah Ismail  
Ina Najwa Ruzaidi

## MOSTI

---

Karen George Abraham  
Dr Hasnul Ambia Abdullah Sani  
Najua Yahaya  
Muhammad Syafiq Dato' Setia Haji  
Mohammad Khusrin  
Balqis Azmi

# FUTURE OF STEM TALENT IN MALAYSIA

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## DISCLAIMER

This document has been prepared by the Malaysian Industry-Government Group for High Technology (MIGHT) exclusively for the Ministry of Science, Technology and Innovation (MOSTI) and other authorised stakeholders as part of the Future of STEM Talent in Malaysia: A Delphi Approach (STI Foresight Report 2025-2040). It presents provisional findings, analyses and recommendations pending final review.

All information is based on research, publicly available sources, stakeholder engagements and expert judgement as of October 2025. While every effort has been made to ensure accuracy, the content remains subject to validation and amendment in the final report.

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## FOREWORD

# MINISTER OF SCIENCE, TECHNOLOGY AND INNOVATION

### **YB Tuan Chang Lih Kang**

Minister of Science, Technology and Innovation



The global landscape is continuously being reshaped by unprecedented technological shifts. From artificial intelligence and biotechnology to the urgent demands of the green economy. The future belongs to nations that can cultivate and command deep expertise in Science, Technology, Engineering and Mathematics (STEM). For Malaysia to realise its ambition of becoming a high-technology nation as envisioned in the Ekonomi MADANI framework, our most critical investment is not merely in infrastructure or capital but in the talents of our people.

Our journey towards 2040 and beyond requires a strategic compass. The STI Foresight Report: Future of STEM Talent in Malaysia, A Delphi Approach is precisely that a forward-looking guide designed to navigate the complexities of our time. This report moves beyond retrospection and provides a meticulously researched vision of the skills and competencies that will define our competitiveness, drive economic value and solve societal challenges in the coming decades. It is our declaration of intent to be proactive rather than reactive in shaping our destiny.

The findings within these pages identify the priority areas that will form the bedrock of our future workforce. It charts a clear course for

transforming our education curricula, aligning industrial training and inspiring a new generation to pursue careers that will build a sustainable and prosperous Malaysia. This is not just an academic exercise; it is a call to action for a grand national coalition uniting policymakers, industry leaders, academics and educators in a shared mission.

We must act decisively and cohesively to nurture a future-ready talent pipeline that is not only technically proficient but also imbued with essential skills like critical thinking, creativity and resilience. By embracing the recommendations of this foresight study, we are laying the cornerstone for an innovation-led economy, one where Malaysian talent is not just participating in the future but actively creating it.

I am confident that this report will serve as an invaluable resource, catalysing the critical conversations and strategic interventions needed to secure Malaysia's place at the forefront of the global technological revolution. Let us work together to build a future where our greatest asset is the ingenuity of our people.

## FOREWORD

# SECRETARY-GENERAL MINISTRY OF SCIENCE, TECHNOLOGY AND INNOVATION

**YBhg. Datuk Seri Hj. Hasnol Zam Zam  
bin Hj. Ahmad**

Secretary-General Ministry of Science,  
Technology and Innovation



The STI Foresight Report: Future of STEM Talent in Malaysia, A Delphi Approach is the culmination of a rigorous, inclusive and forward-thinking process and it is with great pride that The Ministry presents it. This report provides the evidence-based foundation upon which our national STEM talent strategies will be built for years to come. The creation of a strategic document of this magnitude is a testament to the power of collaboration and shared purpose.

At the heart of this study is the Delphi methodology, a robust approach that enabled us to harness the collective intelligence of over 400 experts from across the quadruple helix of government, industry, academia and civil society. This extensive engagement ensures that the insights contained herein are not just theoretical but also deeply rooted in the practical realities and future aspirations of our key economic sectors. The process itself reflects our commitment to data-driven and consultative governance.

The Ministry wishes to extend its deepest appreciation to our strategic partner, the Malaysian Industry-Government Group for High Technology (MIGHT) for their leadership in this initiative. Our gratitude also goes to the Korea Institute of S&T Evaluation and Planning

(KISTEP) for lending their invaluable international expertise which has significantly enhanced the methodological rigour and global perspective of this study.

This foresight report serves as a vital tool to support our partner agencies. It provides a clear prioritised list of future STEM skills that will guide our efforts in policy formulation, resource allocation and programme implementation. It allows us to move in concert, ensuring that our initiatives from scholarship planning and curriculum development to talent retention policies are synchronised and directed towards a common set of national missions.

The publication of this report marks not the end of a journey, but the beginning of one. The Ministry is fully committed to championing its recommendations and facilitating the multi-stakeholder collaborations required to translate this strategic foresight into practical action plans and tangible outcomes. The Ministry thanks every individual and organisation who contributed time and expertise to this landmark study. Together, we will build a resilient and highly skilled STEM talent pool that will power Malaysia's progress.

## FOREWORD

# PRESIDENT AND CHIEF EXECUTIVE OFFICER, MIGHT

### **Ts. Rushdi Abdul Rahim**

President and Chief Executive Officer,  
Malaysian Industry Government Group for High  
Technology (MIGHT)



At MIGHT we believe the best way to anticipate the future is to design it together, through our 3Cs of Conversation, Collaboration and Co-creation, so that choices about technology and talent are made with foresight. For us, foresight is first and foremost about preparedness, creating space to anticipate change and explore responses before they are forced upon us.

This inaugural STI Foresight Report 2025-2040 focusing on the Future of STEM Talent in Malaysia looks beyond today's concerns and asks what STEM knowledge and skills will matter most as new technologies and industries emerge. By combining horizon scanning, technology foresight and structured expert judgement through a Delphi methodology, the study distils a complex landscape into a clear view of the STEM capabilities that can deliver the greatest value for Malaysia.

This report is not a prescriptive blueprint. It is an invitation to think differently about preparedness and a guide for anticipatory thinking, helping stakeholders explore pathways, review options and consider the implications of emerging technologies before they take shape. The world that Malaysia's STEM graduates will inherit is shaped by uncertainty, from technological

disruption to the development of new industries. We cannot remove this uncertainty, but we can prepare for it.

What you will find in this report is a structured view of where demand for STEM capabilities is likely to grow, how these needs cut across sectors and what this means for education, training and workforce strategies. The ten prioritised STEM skills and thematic clusters offer a common language that policy makers, funders, educators and employers can use when they make decisions about scholarships, curricula, industrial attachments, reskilling programmes and investment in research and innovation.

MIGHT would like to record its appreciation to MOSTI for its confidence and leadership, and to the stakeholders who contributed their time and insights to this study. Their participation and dedication has made it possible to take this important first step towards a more future prepared STEM talent ecosystem.

Together, let us use this report to catalyse better conversations, co-create coherent actions and achieve stronger outcomes for better futures.

# EXECUTIVE SUMMARY

Malaysia’s path to a high-income, innovation-led economy depends on a deliberate, whole-of-system effort to build, deploy and retain future STEM talent. This foresight study looks beyond the 2030 income threshold to a 2025–2040 horizon, so capability can be grown through a full cycle of education, adoption and maturation in line with structural shifts in demographics, climate and technology.

## PURPOSE AND APPROACH

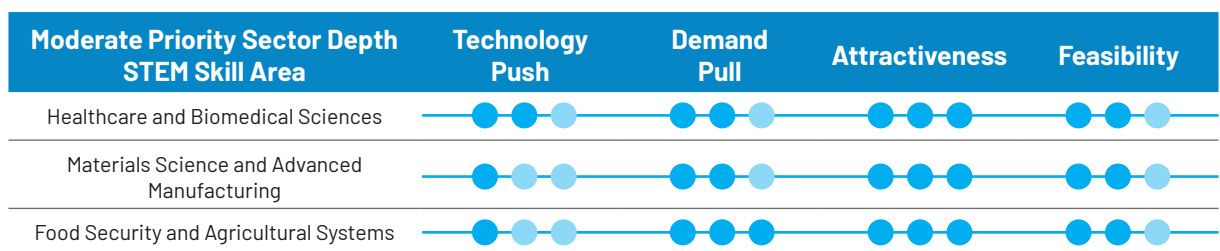
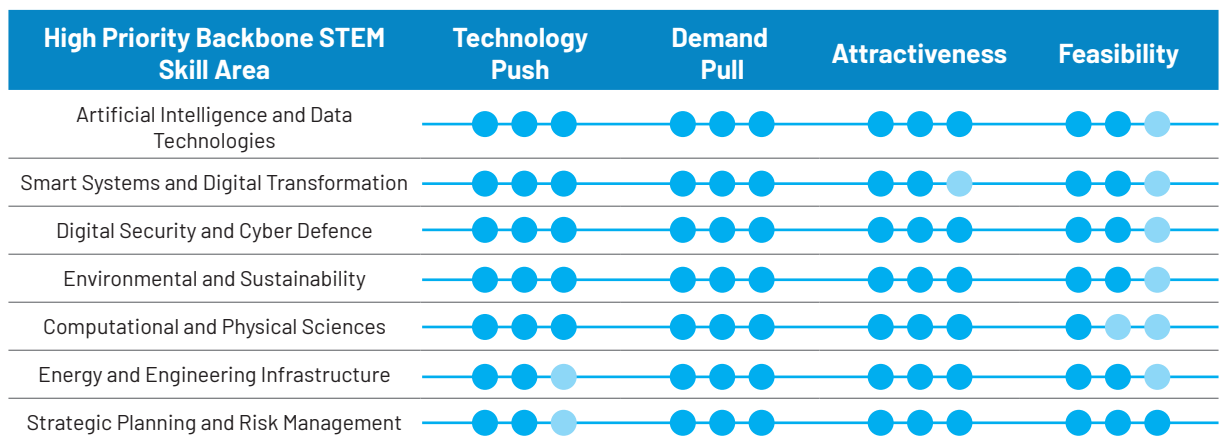
The study integrates horizon scanning, stakeholder engagements, technology assessment and a two-round Delphi to identify the STEM areas and skills Malaysia most needs and can feasibly grow. The methodology proceeds across five stages, culminating in a consensus ranking of skills on two criteria: attractiveness for national value creation and feasibility of the current ecosystem.

## WHAT MATTERS MOST TO 2040

Ten STEM Skill Areas frame national capability building:

1. Artificial Intelligence and Data Technologies
2. Computational and Physical Sciences
3. Digital Security and Cyber Defence
4. Energy and Engineering Infrastructure
5. Environmental and Sustainability
6. Food Security and Agricultural Systems
7. Healthcare and Biomedical Sciences
8. Materials Science and Advanced Manufacturing
9. Smart Systems and Digital Transformation
10. Strategic Planning and Risk Management

From the study, a clear backbone emerges:



Across technology push, demand pull, feasibility and attractiveness, a clear national backbone emerges in Artificial Intelligence and Data Technologies, Smart Systems and Digital Transformation, Digital Security and Cyber Defence, Environmental and Sustainability, and Strategic Planning and Risk Management. These areas combine strong momentum with broad market pull and sufficient feasibility for early scaling. Close to this backbone are Energy and Engineering Infrastructure and Computational and Physical Sciences, which merit steady investment to lift feasibility and convert demand into implementation.

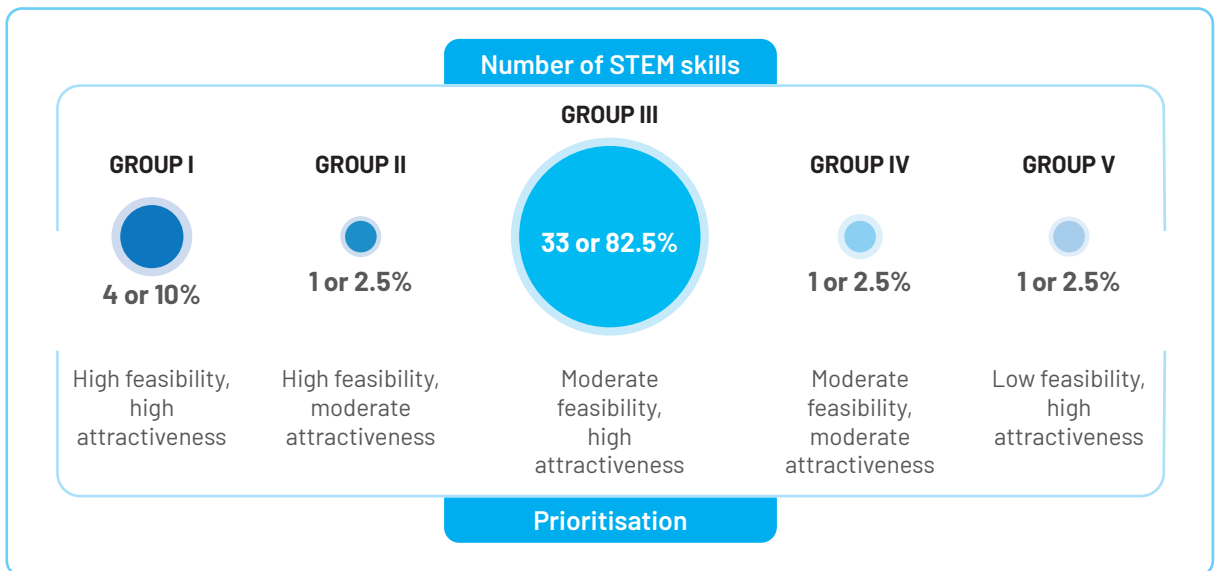
Healthcare and Biomedical Sciences, Materials Science and Advanced Manufacturing and Food Security and Agricultural Systems provide sector depth. Their high attractiveness with mixed feasibility points to the need for targeted enablement. The backbone should anchor curriculum renewal, educator development and shared digital and research platforms, while sector-specific areas advance through mission-linked projects, testbeds and pooled facilities that progressively raise feasibility.

## WHAT THE SKILL PRIORITISATION SHOWS

The Delphi identifies and prioritises 40 STEM skills into five groups using an Attractiveness-Feasibility lens.

Immediate priorities sit in Group I, where both attractiveness and feasibility are high, indicating capabilities that can scale now through existing programmes and facilities. A small Group II is feasible and ready for targeted, value-driven expansion.

Most skills fall in Group III: high attractiveness with only moderate feasibility. These offer strong payoffs once bottlenecks in tools, supervised practice, mentorship, assessment and approvals are cleared. Focused enablement can move many into Group I within two to five years through shared platforms and testbeds, applied projects and work-integrated learning, train-the-trainer pathways, competency standards and proportionate sandboxes. Smaller Groups IV and V remain attractive but constrained by capability, infrastructure or regulatory readiness and should progress via mission-led pilots. Eighteen skills did not reach the threshold and are placed on a watchlist for continued scanning and evidence gathering.





## AMBITIONS FOR NAVIGATING MALAYSIA'S FUTURE STEM TALENT

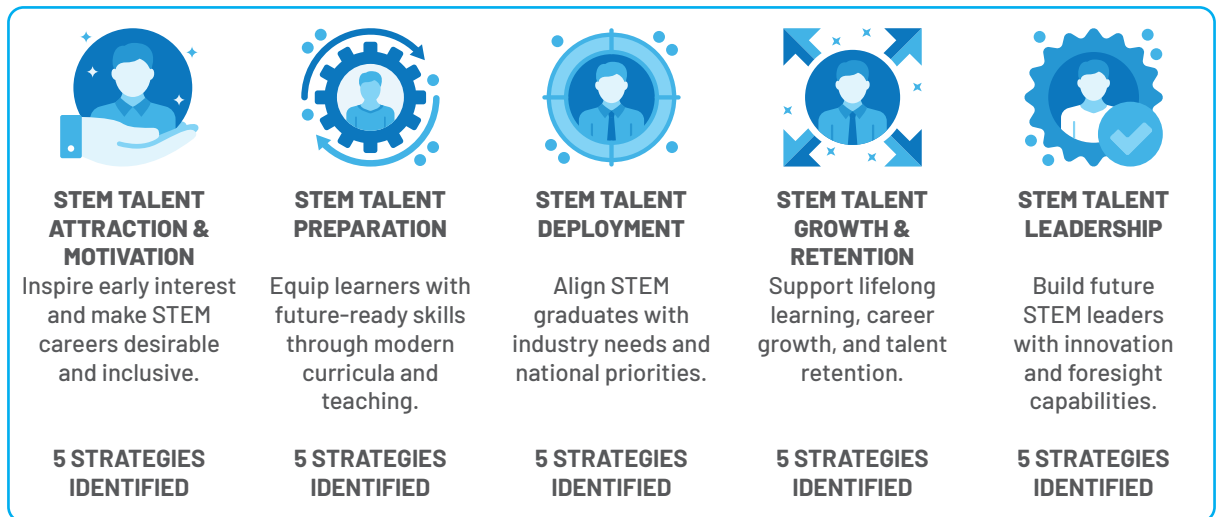
Malaysia's skills map signals clear opportunities:

- Data-rich services powered by artificial intelligence.
- Advanced manufacturing secured by strong cyber defences.
- Greener, circular operations across energy, industry and cities.
- Precision production and engineering reliability.
- Safety, quality and regulatory science in health and other high-risk domains.

However, key challenges persist. Adoption is uneven across regions and firm sizes. Many SMEs face higher entry costs and limited access to

mentors, facilities and compute. Gaps in language readiness, pedagogy and supervised practice slow workplace performance, especially in AI, data and cyber roles. Fragmented governance and slow approvals hold back scale in regulated fields such as health, energy and critical infrastructure. Talent mobility is constrained between universities, TVET, industry and the public sector, with weak incentives for continuous upskilling.

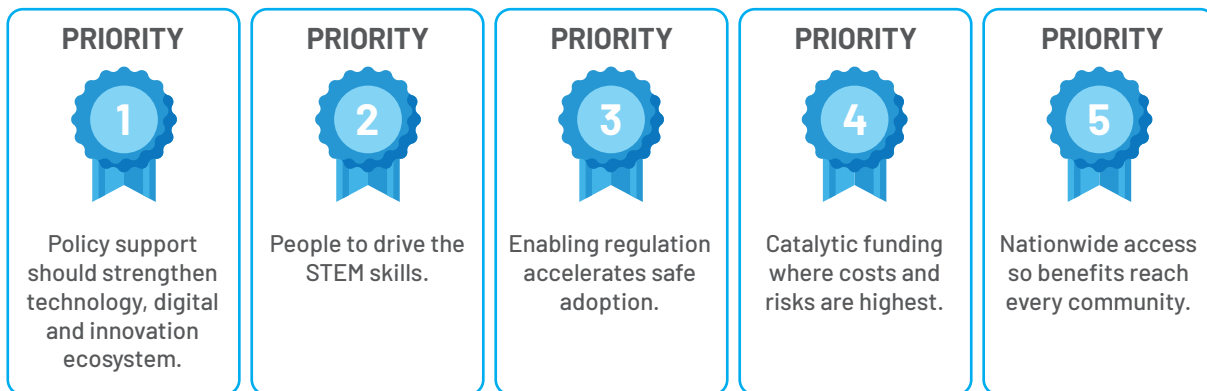
Real gains come from pairing these opportunities and constraints with strategies that create demand, build practice, and remove friction to scale. The strategic options are organised across five themes and three levels of ambition: sustain what already works and scale it, improve and expand current efforts, and pursue bold moves that future proof the ecosystem.



As this is an advisory foresight report, recommendations are high level and non-prescriptive. The study does not model headcounts or wages and reflects purposive expert sampling. The intent is to inform anticipatory decision making and to be adapted through co-design with lead agencies, phasing pilots and feasibility work where major investments or regulatory change are contemplated.

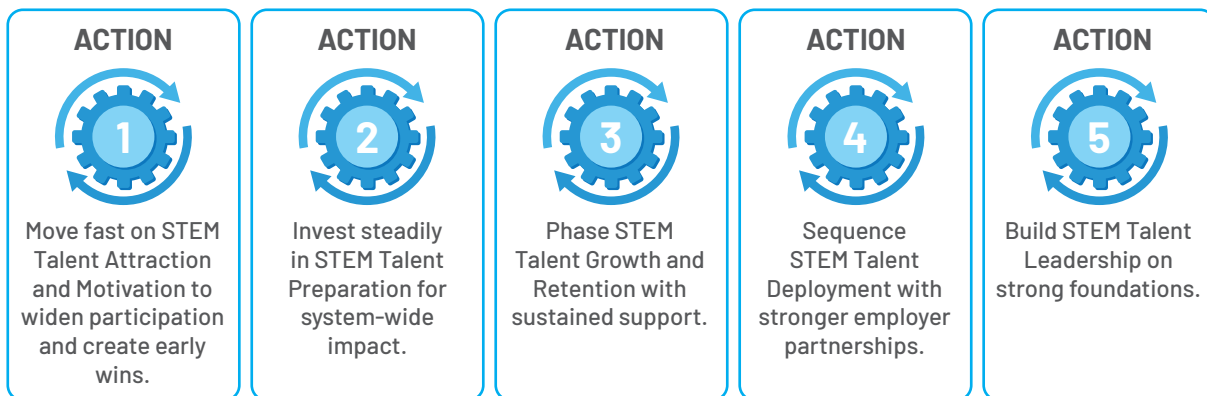
## THE ENABLING PLATFORM FOR DELIVERY

Five system priorities shape how Malaysia should act:



## SEQUENCING ACTION TO 2040

Malaysia cannot do everything at once. Stakeholder assessment points to a practical order of effort:



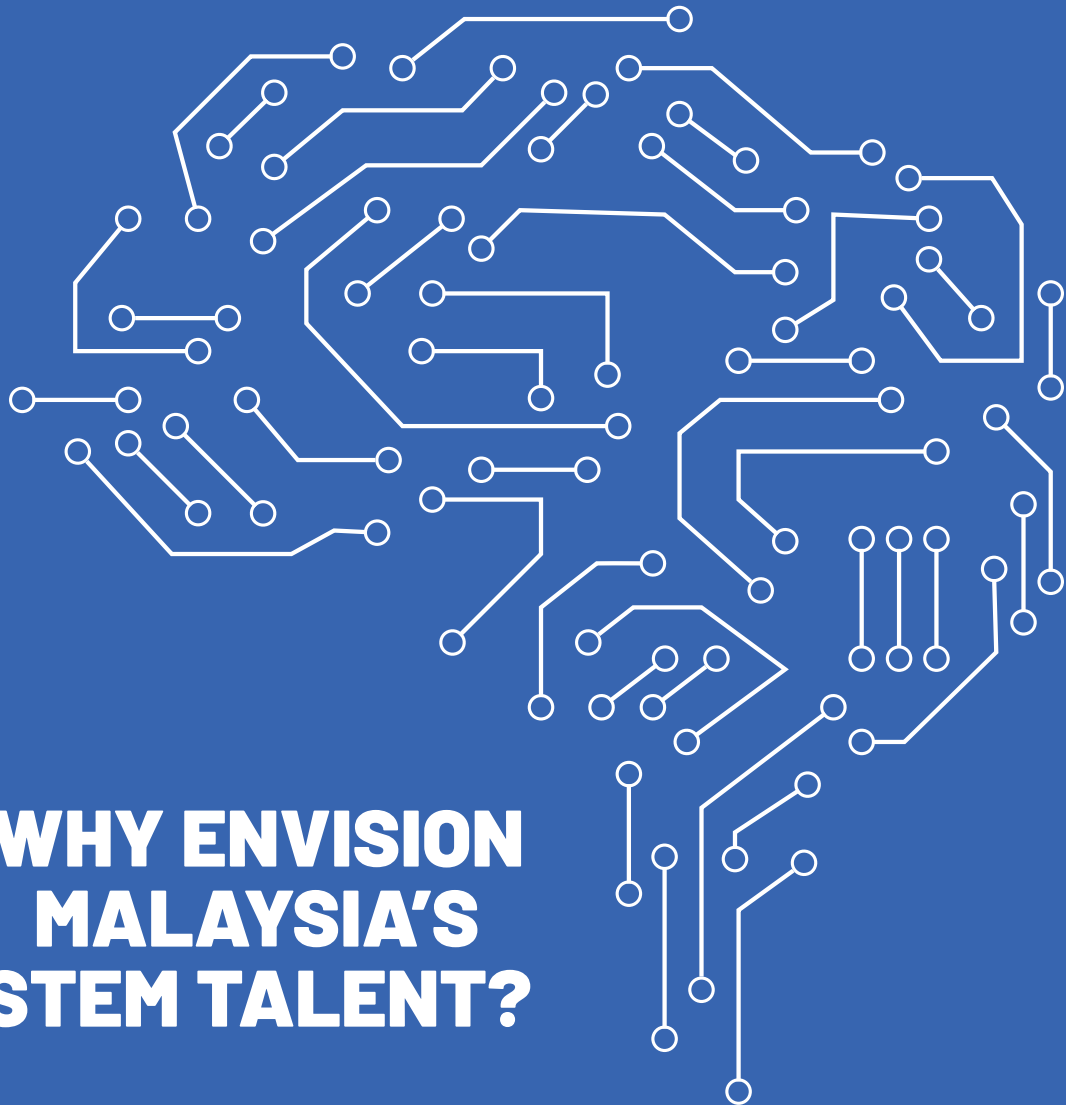
Early quick wins can come from skills that are both attractive and ready to scale, including Data Analytics and Visualisation, Workplace Safety and Health Management, Advanced Installation, Maintenance and Reliability Engineering, and Environmental Management. Use these to build momentum while deeper reforms take root.

## WAY FORWARD AND STEWARDSHIP

Translate the skills map into curricula and assessment, teacher development, equipment and shared platforms, employer demand signals and targeted finance. Track a small set of skill-based indicators and refresh through regular scanning, so the skills outlook stays current as technologies and markets evolve.

Acting now widens participation, lifts confidence and signals commitment to learners, employers and investors. Over time, sustained improvements in curriculum, pedagogy, applied learning and language readiness, coupled with lifelong learning and research translation, will retain talent and move firms into higher value activities. Delay risks deeper mismatches, slower adoption and lost ground in strategic industries.

# CHAPTER 1



**WHY ENVISION  
MALAYSIA'S  
STEM TALENT?**

# WHY ENVISION MALAYSIA'S STEM TALENT?

Malaysia's journey towards becoming a high-income, innovation-driven economy is increasingly dependent upon the strategic foresight and proactive development of Science, Technology, Engineering and Mathematics (STEM) talent. Globally, leading economies such as Singapore, South Korea, Germany and Switzerland demonstrate a clear link between robust STEM talent ecosystems with sustained economic competitiveness, innovation capacity and social prosperity. This relationship is consistently reflected in international benchmarks, notably the Global Innovation Index, World Competitiveness Ranking and Global Talent Competitiveness Index among others, where strong STEM talent development significantly enhances a nation's standing and attractiveness to global investors.

Malaysia targets crossing the World Bank high income GNI per capita threshold by 2030. This study therefore looks beyond 2030 to ensure that high income is achieved, sustained and translated into innovation-led prosperity. A 2025 to 2040 horizon captures the full cycle required to build, deploy and mature STEM capabilities that underpin the next S curve of growth. It also positions Malaysia to manage structural shifts that intensify after 2030, including demographic change, climate and energy transitions and technological convergence across AI, advanced manufacturing, health and green solutions.

In pursuit of its national vision to emerge as a high-tech, globally competitive economy, Malaysia recognises STEM talent as a cornerstone of future success. By strategically nurturing advanced STEM skills, Malaysia aims to catalyse transformative innovation, enhance productivity and strengthen its global economic positioning. A capable STEM talent pool is critical not only for driving high-value technological advancement but also for providing agile and responsive solutions to emerging national challenges, ensuring effective policy implementation and inclusive growth.

This chapter introduces the critical imperative for envisioning Malaysia's STEM talent landscape between 2025 and 2040. It sets out the rationale behind this foresight initiative, clearly defining the scope, objectives and approach adopted in this study. Furthermore, it clarifies how STEM talent is conceptualised within Malaysia's strategic economic framework, establishing a foundation for interpreting the subsequent findings and recommendations.

“

A 2025 to 2040 horizon captures the full cycle required to build, deploy and mature STEM capabilities that underpin the next S curve of growth.

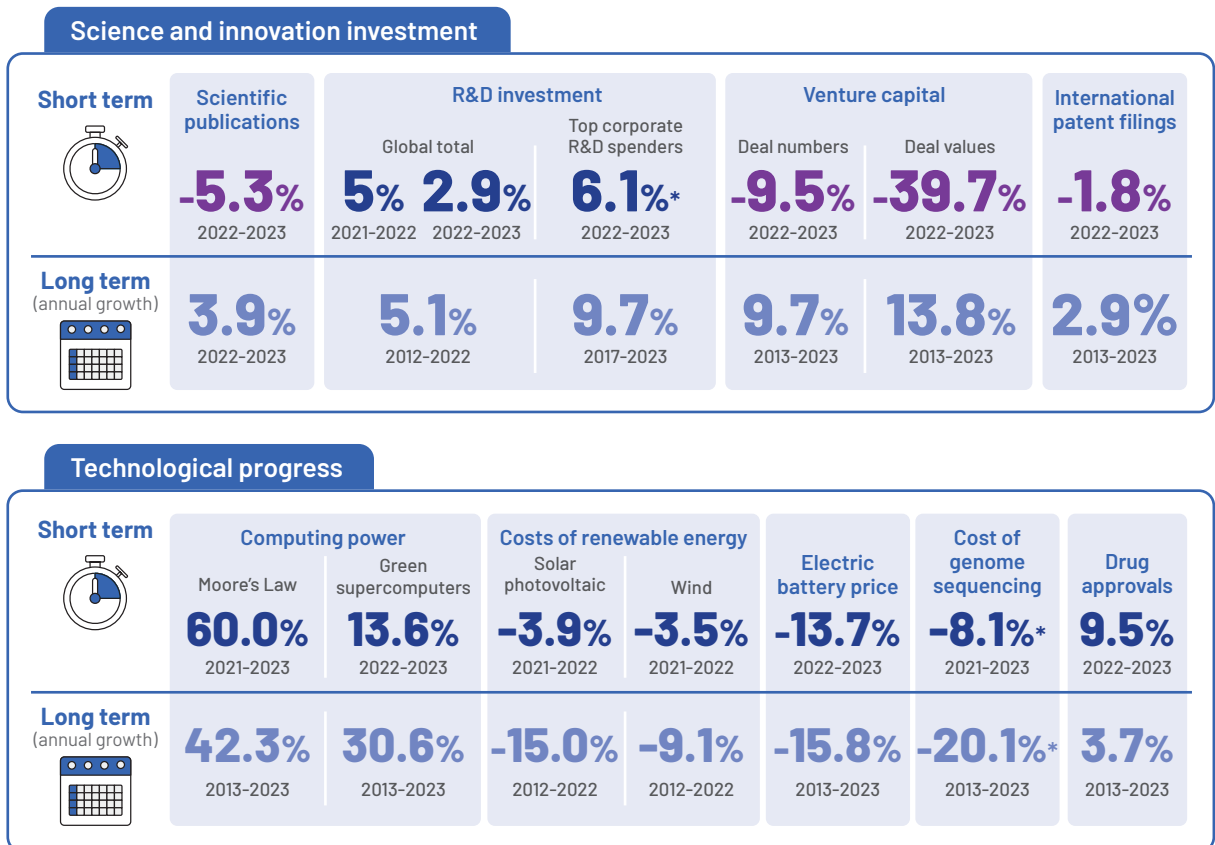
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## 1.1 STRATEGIC IMPORTANCE OF STEM TALENT

STEM talent has become a defining asset in a nation's capacity to respond to global shifts, unlock economic value and drive sustained innovation. In an era marked by rapid technological advancement, climate adaptation, demographic change and evolving geopolitical dynamics, STEM capabilities are no longer optional. They are foundational to long-term resilience, relevance and competitiveness.

### STEM TALENT FOR DRIVING THE FUTURE OF INNOVATION

Recent findings from the Global Innovation Tracker 2024 (Figure 1.1), highlight how global innovation activity continues to be deeply rooted in STEM-intensive domains (WIPO, 2025). Despite economic uncertainties, corporate research and development spending grew by 6.1 percent in 2023, while core technology areas such as computing power (13.6 percent), robotics (12.2 percent) and electric vehicles (53.8 percent) registered robust progress. These gains not only reflect continued momentum in science and technology investment but also signal the expanding demand for highly skilled STEM professionals capable of sustaining innovation through uncertainty.



## Technology adoption




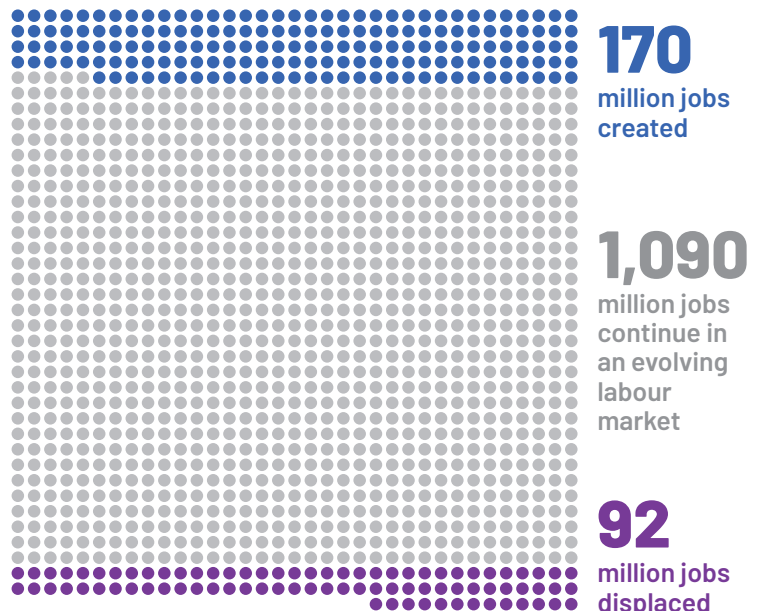
	Safe sanitation	Connectivity	Robots	Electric vehicles	Cancer radiotherapy	
<b>Short term</b> 	2021-2022	Fixed broadband 2022-2023	5G 2022-2023	2021-2022	2022-2023	
	<b>1.4%</b>	<b>4.5%</b>	<b>22.6%</b>	<b>12.2%</b>	<b>53.8%</b>	<b>2.7%</b>
<b>Long term</b> (annual growth) 	2012-2022	2013-2023	2021-2023	2012-2022	2013-2023	
	<b>2.4%</b>	<b>6.7%</b>	<b>45.3%</b>	<b>12.2%</b>	<b>58.9%</b>	<b>1.6%</b>
<b>Penetration</b> 	57 of 100 inhabitants in 2022 (45 in 2012)	19 per 100 inhabitants in 2023 (10 in 2013)	38% of global population in 2023 (18% in 2021)	n.a.	3 out of 100 cars in 2023 (0.04 in 2013)	21 out of 100 countries met requirements in 2023

Figure 1.1 Global Innovation Tracker 2024 highlighting the importance of STEM in innovation.

These advances are not isolated from talent needs. Rather, they reflect the demand for a workforce that can develop, operate and scale complex technologies. The adoption of 5G connectivity and electric mobility, for example, relies not only on infrastructure investment but also on engineers, data scientists and systems integrators capable of delivering real-world solutions.

## STEM TALENT FOR THE FUTURE OF WORK

The rising importance of STEM talent is clearly reflected in global labour market outlooks. According to the World Economic Forum Future of Jobs Report 2025, an estimated 170 million new jobs will be created globally by the end of this decade, while 92 million roles are expected to be displaced (Figure 1.2). This net job growth underscores a major transformation in the nature of work, with the strongest momentum concentrated in STEM domains.



Source: World Economic Forum. (2025). Future of Jobs Report 2025.

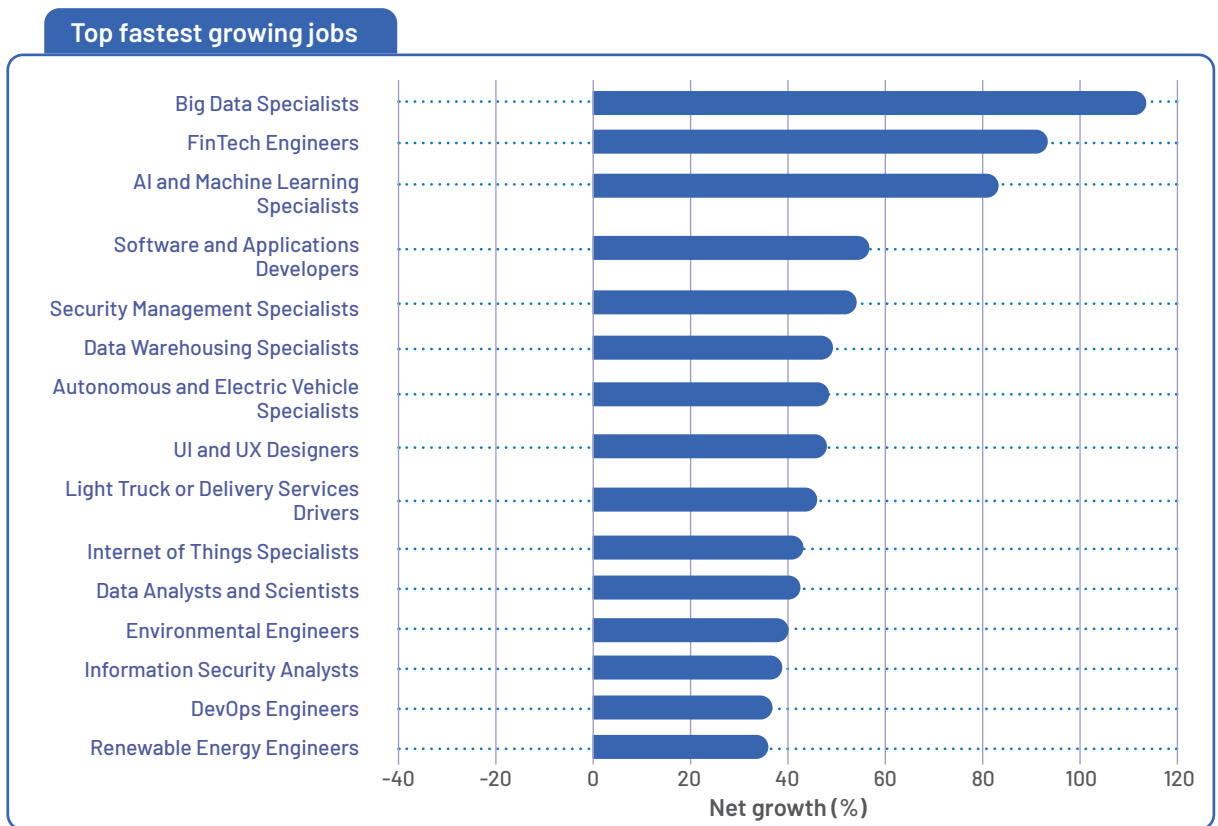
Figure 1.2 Total job growth and loss by 2030.

The fastest growing roles between 2025 and 2030 are overwhelmingly STEM-related (Figure 1.3). With over 86 percent of companies planning to integrate artificial intelligence into their operations, there is a sharp rise in demand for Big Data Specialists, AI and Machine Learning Specialists, FinTech Engineers, Software Developers, Cybersecurity Analysts, Internet of Things (IoT) Specialists, Environmental Engineers and Renewable Energy Engineers. These roles are not only central to technological progress but also critical to advancing sustainable transitions and long-term economic competitiveness.

In contrast, many of the fastest declining roles are routine-based and less STEM-intensive, including postal clerks, data entry clerks, bank

tellers, cashiers and other clerical occupations. This divergence reflects how global labour markets are being reshaped by automation, AI and digitalisation. As the demand for complex problem-solving, digital fluency and innovation capacity accelerates, jobs reliant on repetitive tasks face growing risk of obsolescence.

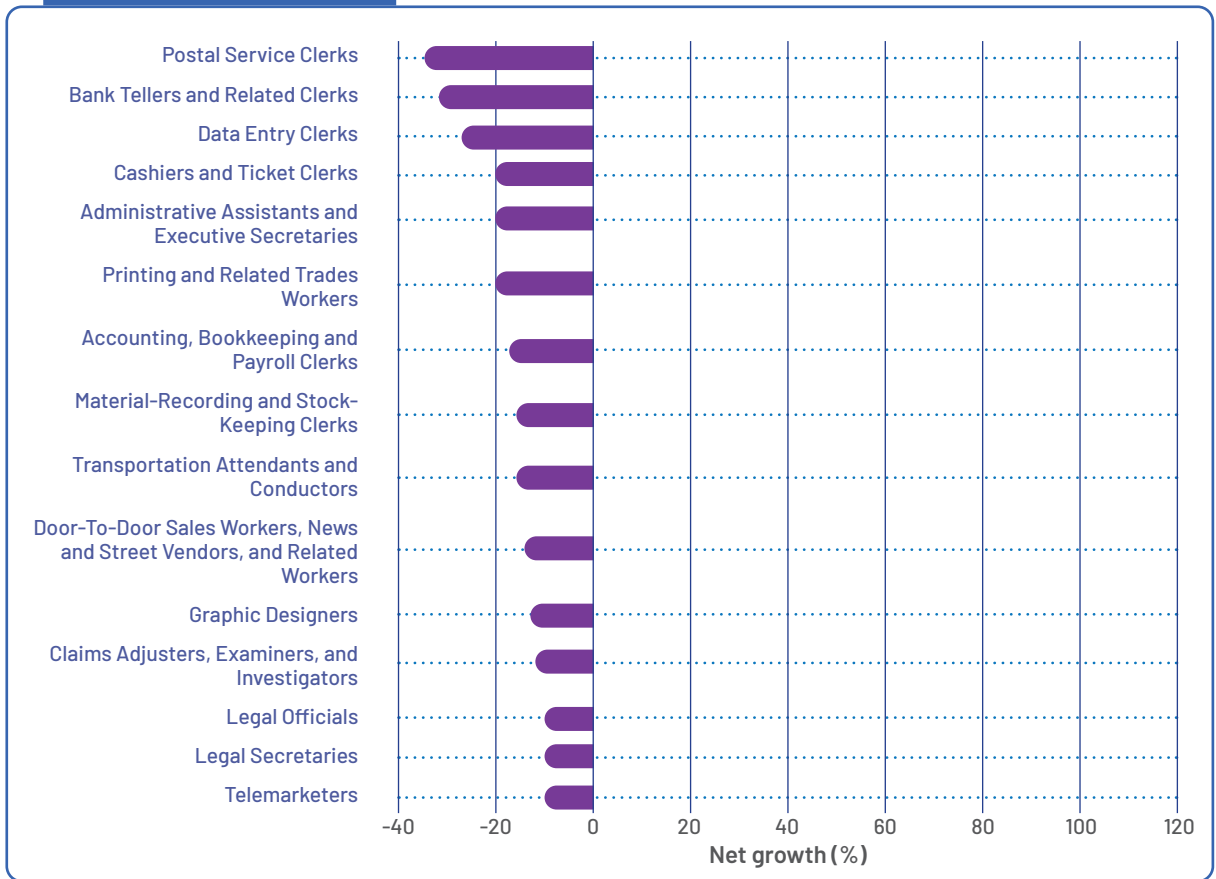
For Malaysia, these trends highlight the strategic imperative of strengthening its STEM talent pipeline. This is not only key to enhancing national innovation and economic performance, but also to future-proofing the workforce. A strong STEM foundation will enable Malaysian talent to adapt across industries, remain resilient amid disruption and seize high-value opportunities in the rapidly evolving global economy.



Source: World Economic Forum, Future of Jobs Survey, 2024.

Figure 1.3 Top fastest growing and declining jobs.

## Top fastest declining jobs



Source: World Economic Forum, Future of Jobs Survey, 2024.

Figure 1.3 Top fastest growing and declining jobs.

## STEM TALENT FOR FUTURE COMPETITIVENESS

The growing importance of STEM talent cuts across economic, social and policy dimensions. It is no longer confined to specialised industries but is becoming a foundation of national capability and resilience. Malaysia's focus on strengthening its STEM ecosystem is not only about filling existing skills gaps. It is about equipping the nation to respond to global signals and to lead in areas of emerging potential.

As Malaysia seeks to climb the value chain and assert its position as a regional technology and innovation hub, demand for skilled STEM professionals will only continue to rise. Key sectors such as advanced manufacturing, green technology, health sciences, agriculture and digital services require a steady supply of multidisciplinary and future-ready talent.

Beyond driving industry, STEM talent also supports broader national aspirations. It contributes to productivity gains, inclusive innovation and improved quality of life. It strengthens Malaysia's attractiveness to investors, especially in high-growth technology domains.

Most importantly, the impact of STEM talent goes beyond technical delivery. It enables agile policy implementation, supports evidence-based governance and advances science-informed decision-making. As Malaysia charts its path towards becoming a high-tech nation, investing in STEM talent should be treated as a shared national priority spanning education, industry, government and society.

This foresight study recognises that STEM talent development is not only a workforce issue. It is a strategic imperative for resilience, capability and future competitiveness in a rapidly changing world.

## 1.2 OVERVIEW OF THE STUDY

### 1.2.1 STUDY BACKGROUND AND OBJECTIVES

The Future of STEM Talent in Malaysia: A Delphi Approach (STI Foresight Report 2025-2040) study was commissioned by the Ministry of Science, Technology and Innovation (MOSTI) as part of its ongoing efforts to strengthen Malaysia's science and technology ecosystem. MIGHT was appointed as the lead implementing agency to undertake this strategic foresight study, building on its experience in long-term futures thinking, stakeholder engagement and policy advisory support.

This study responds to the increasing urgency to anticipate and prepare for changes in Malaysia's talent landscape in light of rapid technological advancement and global megatrends. As Malaysia aspires to become a high-tech, high-income nation, strengthening the STEM talent pipeline is crucial for economic transformation, innovation-led growth and national resilience.

This foresight study is intended as an advisory report. It is not a policy document, but a preliminary knowledge base developed to support decision-makers, planners and stakeholders in making informed choices. It aims to surface emerging signals, synthesise strategic insights and provide reference points for both current policy implementation and the development of future STEM-related strategies. The findings are meant to encourage foresightful planning and foster long-term thinking on the future of STEM talent in Malaysia.

The core objectives of the study, as outlined in the Terms of Reference, are to:

1

Provide foresight into global and local trends, drivers and future scenarios to identify opportunities and vulnerabilities

2

Engage strategically with stakeholders to explore the potential of STEM in Malaysia

3

Analyse and identify STEM priority areas that could offer future economic value to Malaysia

### 1.2.2 STUDY SCOPE

For the purpose of this foresight study, STEM talent refers to individuals equipped with knowledge, skills and competencies in the domains of Science, Technology, Engineering and Mathematics, who contribute meaningfully across Malaysia's innovation, research and industrial ecosystems. This definition is referenced from the National STEM Action Plan (MOSTI, 2018) and reflects a broad and inclusive view of talent required to support national socio-economic transformation.

The classification of STEM fields within this report adheres to the National Education Code (NEC-2020), which provides a structured framework for categorising educational disciplines. The relevant NEC-2020 codes included in the definition of STEM talent are as follows:

**NEC 05** Natural Sciences, Mathematics and Statistics

**NEC 06** Information and Communication Technologies

**NEC 07** Engineering, Manufacturing and Construction

**NEC 08** Agriculture, Forestry, Fisheries and Veterinary

**NEC 09** Health and Welfare

**NEC 10** Services

These codes represent the core domains where STEM talent is most essential, particularly in areas that are expected to drive innovation and contribute significantly to Malaysia’s economic growth in the coming decades.

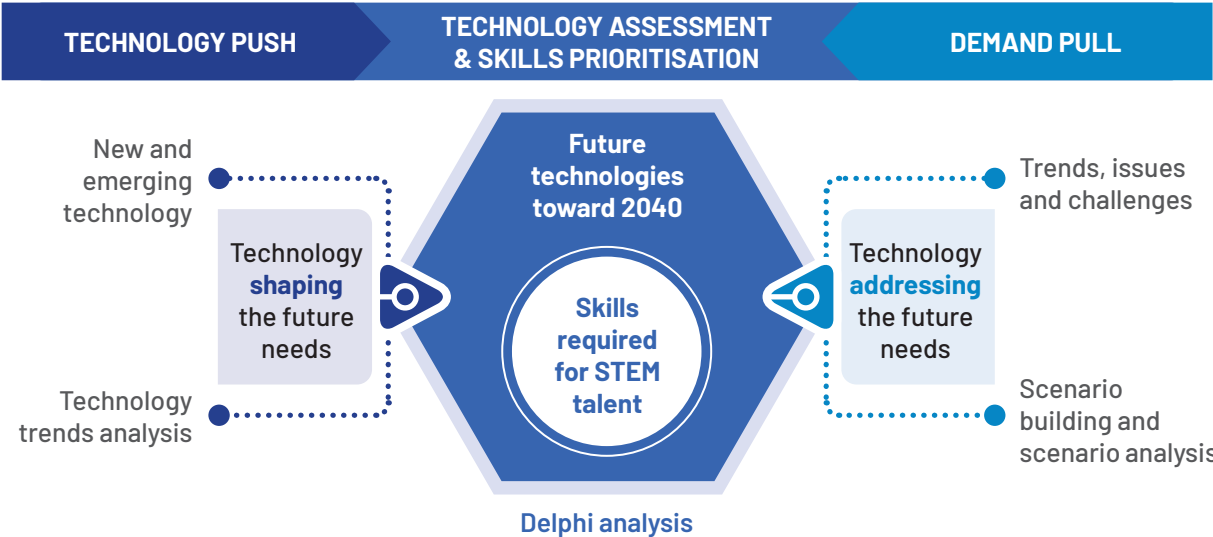
STEM talent is not limited to academic researchers or technical professionals. It includes a wide range of roles, such as technicians, engineers, data scientists, software developers, science communicators and STEM-literate decision-makers across varying levels of education and expertise. Both academic and technical-vocational pathways are considered within scope, given Malaysia’s need for a diverse and agile workforce to support its ambitions in high-technology and innovation-driven development.

In line with the forward-looking orientation of this study, the scope also includes future-ready skills and competencies that are expected to be critical in responding to emerging technologies, shifting industry needs and broader global changes. These include digital fluency, computational thinking, design and systems thinking, environmental and sustainability literacy and interdisciplinary problem-solving.

By adopting an inclusive and anticipatory framing of STEM talent, this study aims to support a more robust and adaptive approach to talent development that can sustain Malaysia’s long-term resilience, relevance and competitiveness.

### 1.2.3 STUDY APPROACH & METHODOLOGY

This foresight study combines MIGHT’s established methodology with insights drawn from the Korean Technology Foresight model and 6th Science and Technology Foresight (2021 -2045) by Korea Institute of S&T Evaluation and Planning (KISTEP). It employs two complementary perspectives, technology push and demand pull, to anticipate Malaysia’s STEM talent needs up to 2040 (Figure 1.4).



Adapted from General Framework of Korean Technology Foresight Activities with MIGHT Foresight Approach

Figure 1. 4 Technology push and demand-pull study approach.

Technology push identifies and filters new and emerging technologies that will shape Malaysia's future STEM skills requirements. This process unfolds through four successive activities (Figure 1.5):

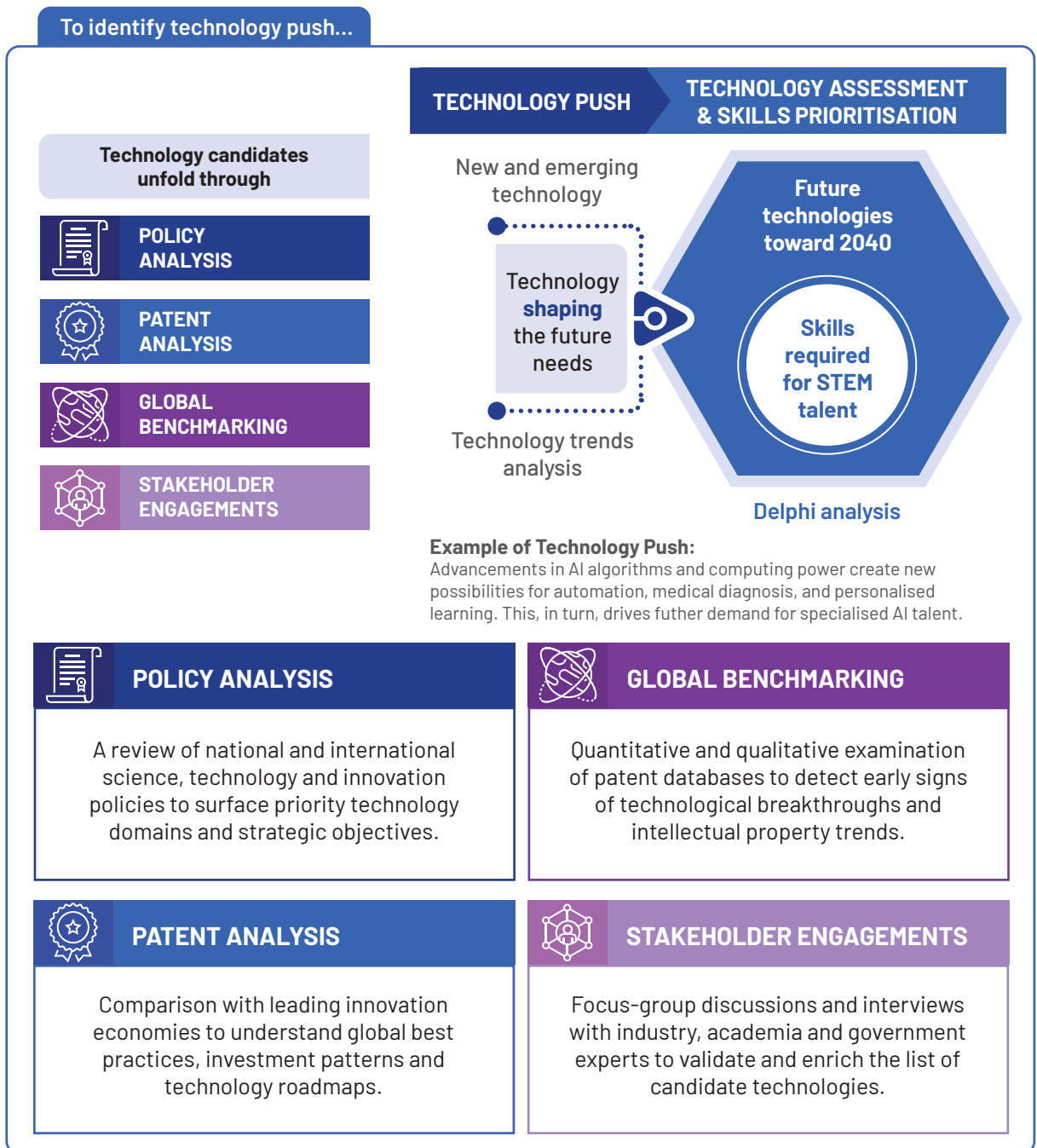


Figure 1.5 Process to identify technologies and STEM skills through technology push.

Meanwhile, demand pull explores how evolving industry requirements, policy aspirations and societal challenges generate requirements for specific STEM capabilities. This process unfolds through four successive activities (Figure 1.6):

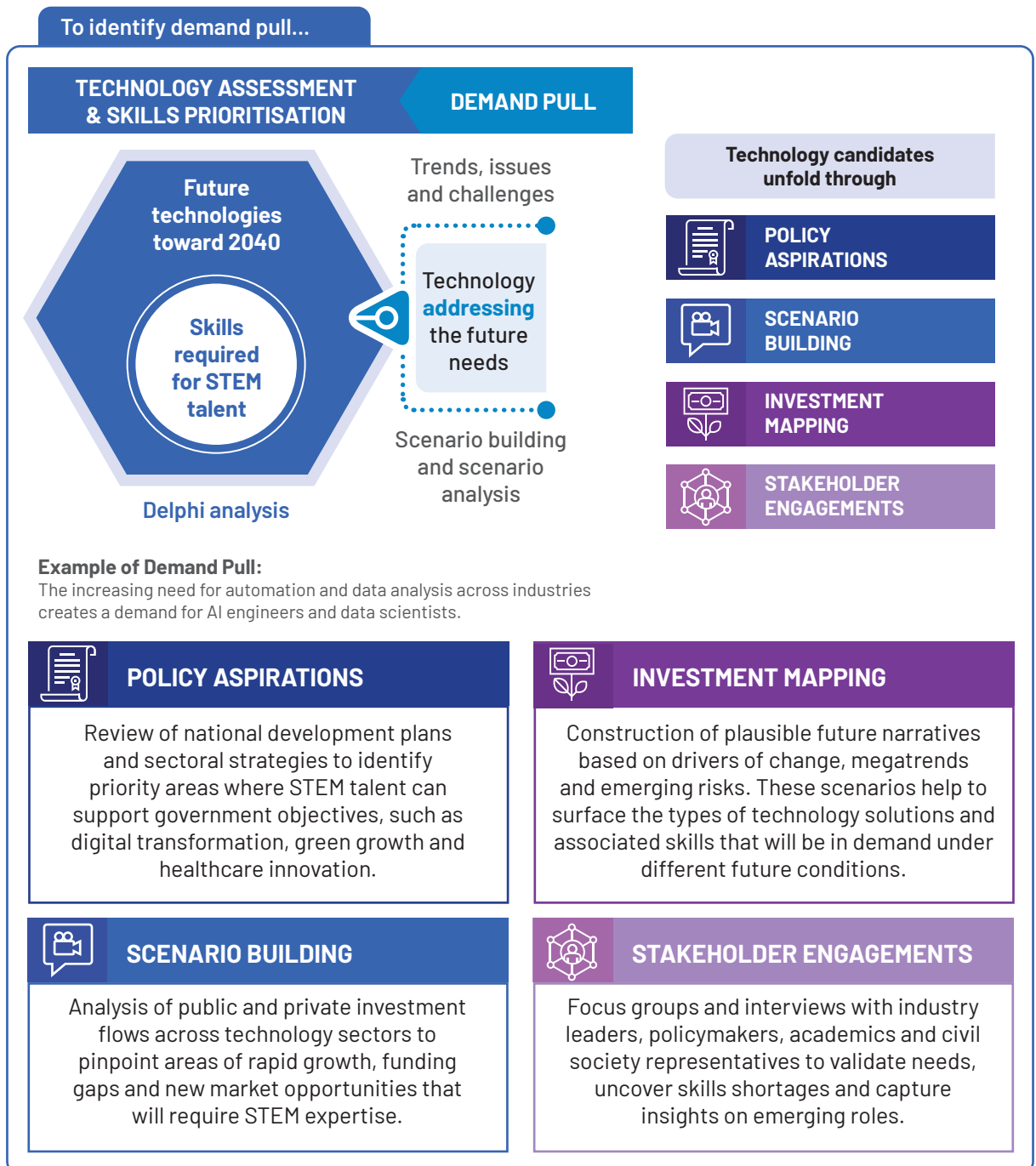


Figure 1.6 Process to identify technologies and STEM skills through demand pull.

Together, these dual lenses ensure that the study's subsequent technology assessment and skills prioritisation steps rest on a robust understanding of both cutting-edge technological advances and the real-world drivers of talent demand.

The methodology unfolds in five stages, each integrating technology analysis, demand-side insight and stakeholder input to build a robust, locally grounded foresight (Figure 1.7).

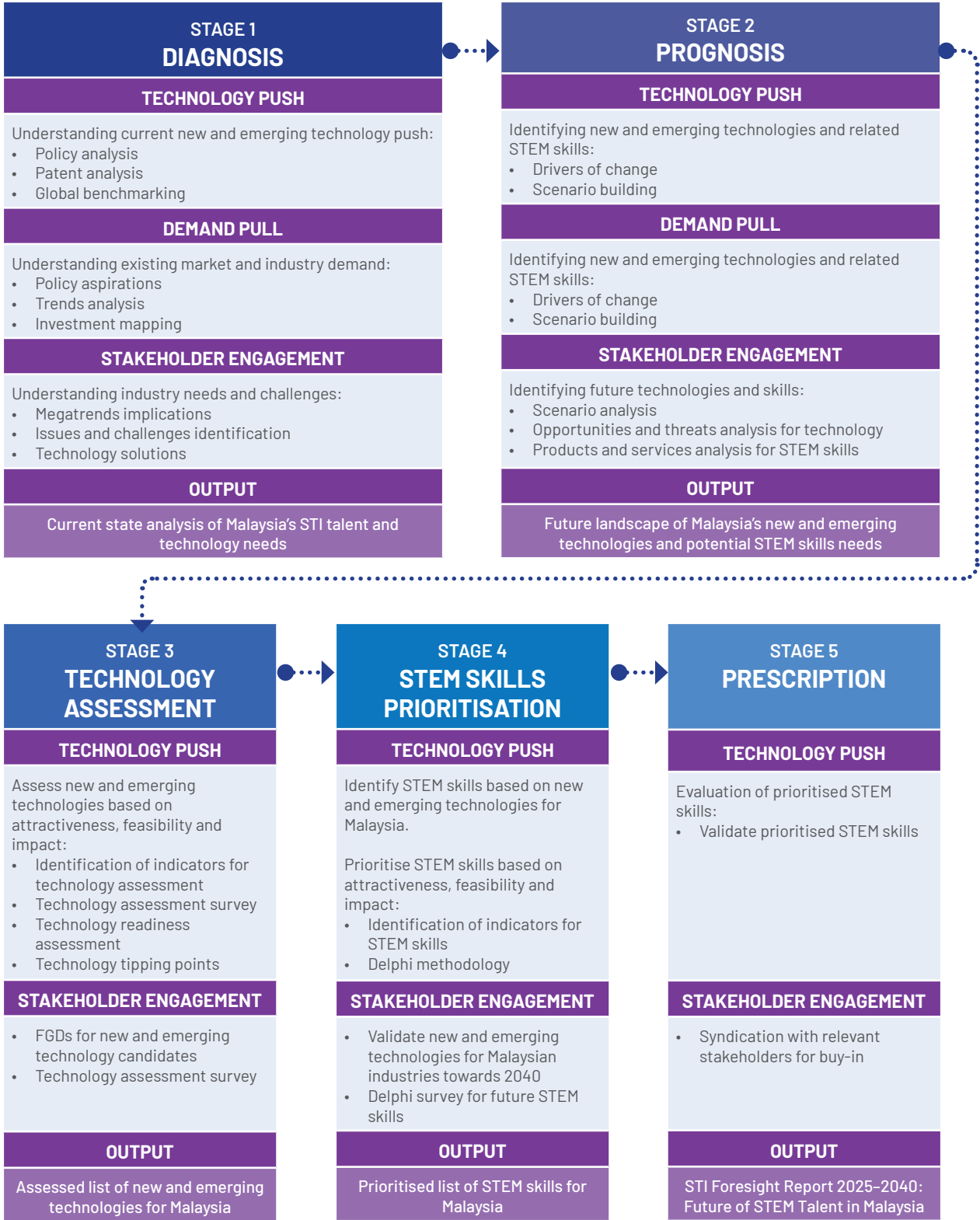


Figure 1.7 Five stage methodology to identify future STEM skills in Malaysia.



### STAGE 1: DIAGNOSIS

The study began by mapping Malaysia's existing STEM talent pool and technology landscape. National and international STI policies were reviewed, patent filings analysed and global benchmarks compared to identify priority technology domains. Concurrently, policy aspirations, market trends and investment flows were examined to capture current demand dynamics. Workshops with representatives from industry, academia and government surfaced megatrends, key challenges and potential technology solutions. The output of this stage was a comprehensive baseline of Malaysia's STEM talent and technology needs.



### STAGE 2: PROGNOSIS

Emerging technology candidates were identified through drivers-of-change analysis and scenario building, which generated a set of plausible futures for Malaysia's economy and society. Stakeholder consultations then assessed the opportunities, threats and likely product-service pathways associated with each technology. This stage produced a forward-looking landscape of potential technologies and the STEM skills they would require.



### STAGE 3: TECHNOLOGY ASSESSMENT

A targeted survey was conducted among participants from public, private and academic sectors to evaluate the shortlisted technologies against key criteria: potential applications, industry development prospects, expected realisation timelines and the STEM skills required for their development and deployment. Follow-up discussions were held to validate these findings and ensure they reflected Malaysia's specific context. The outcome was an evidence-based shortlist of technologies most likely to shape future skill demand.



### STAGE 4: STEM SKILLS PRIORITISATION

Delphi methodology was employed to refine and rank the STEM skill candidates identified in earlier stages. A structured questionnaire was circulated to participants from academia, government, industry and training providers, asking them to assess each skill on two key criteria:



**Attractiveness:** its contribution to Malaysia's economic growth and global competitiveness



**Feasibility:** the readiness of education, infrastructure and ecosystem to develop and deploy the skill

Anonymised scoring and multiple feedback rounds produced a consensus-driven, prioritised list of STEM capabilities. These skills represent those most likely to deliver strategic value and can feasibly be grown within Malaysia's talent ecosystem.



### STAGE 5: PRESCRIPTION

In the final stage, strategic options were developed to address the critical skill gaps identified for the prioritised STEM capabilities and to tackle current issues, leverage future opportunities and mitigate emerging risks. These strategic options and enablers span the full STEM talent lifecycle and are recommended as a basis for further discussion, refinement and integration into existing initiatives, with the aim of ensuring Malaysia remains agile, resilient and competitive in an evolving global landscape.



To read more about the study methodology and stakeholder engagements, refer to Appendixes.

## STUDY LIMITATIONS

As stated in the Study Background, this is an advisory foresight report and acts as a preliminary knowledge base to support decision makers, planners and stakeholders. The intent is to surface emerging signals, synthesise strategic insights and offer reference points for current implementation and future STEM strategies. The findings are designed to encourage foresightful planning and long-term thinking on Malaysia's STEM talent.



### Scope boundaries

STEM talent is defined using the relevant NEC codes. Non-STEM domains and granular occupation-by-occupation projections are beyond scope.



### No quantitative labour demand modelling

The report prioritises skills on attractiveness and feasibility. It does not estimate headcounts or wage impacts as this is beyond scope of study and will warrant a deepening exercise using this study as the base.



### Evidence base

Findings synthesise policy reviews, patent scans, benchmarking and stakeholder inputs. Sources are robust but not exhaustive and are constrained by data availability at the time of study.



### Geographic granularity

The primary lens is national. State-level implications can vary and should be interpreted with local context.



### Technology assessment and Delphi panel composition

The methodology employs a purposive sampling which is a non-probability sampling technique where respondents are intentionally selected based on their knowledge, relevance, or experience related to the study. It might not be statistically representative of all sectors. Results reflect consensus among participants and may carry sectoral bias.



### Depth of recommendations

Recommendations are high level and overarching. They are not a roadmap or blueprint and do not prescribe detailed programmes, timelines, budgets, or named responsible stakeholders. They indicate direction and priorities to be translated into implementable plans through subsequent co design with lead agencies and partners.



### Uncertainty in technology maturity and adoption

Pathways and timelines for emerging technologies can shift with regulation, market dynamics, or breakthroughs.



### Time sensitivity

External shocks or policy changes may affect the relevance of some signals and options. Periodic updates are advised.



## Findings from Korea's 6th Science and Technology Foresight (2021-2045): Discovering Future Technologies to Solve Major Issues of Future Society

The 6th Science and Technology Foresight Report provides a useful external reference for Malaysia's horizon scanning. Published by KISTEP in 2022, the report identified 241 future technologies, including 15 that were highlighted as priority "future innovative technologies." All are organised around five societal megatrends and six thematic groups.



### Five Societal Megatrends

1. Digital world
2. Change of social structure
3. Global environmental change and resource exploitation
4. Change of world order
5. Routinised risk

The study categorised the 241 future technologies according to six thematic groups

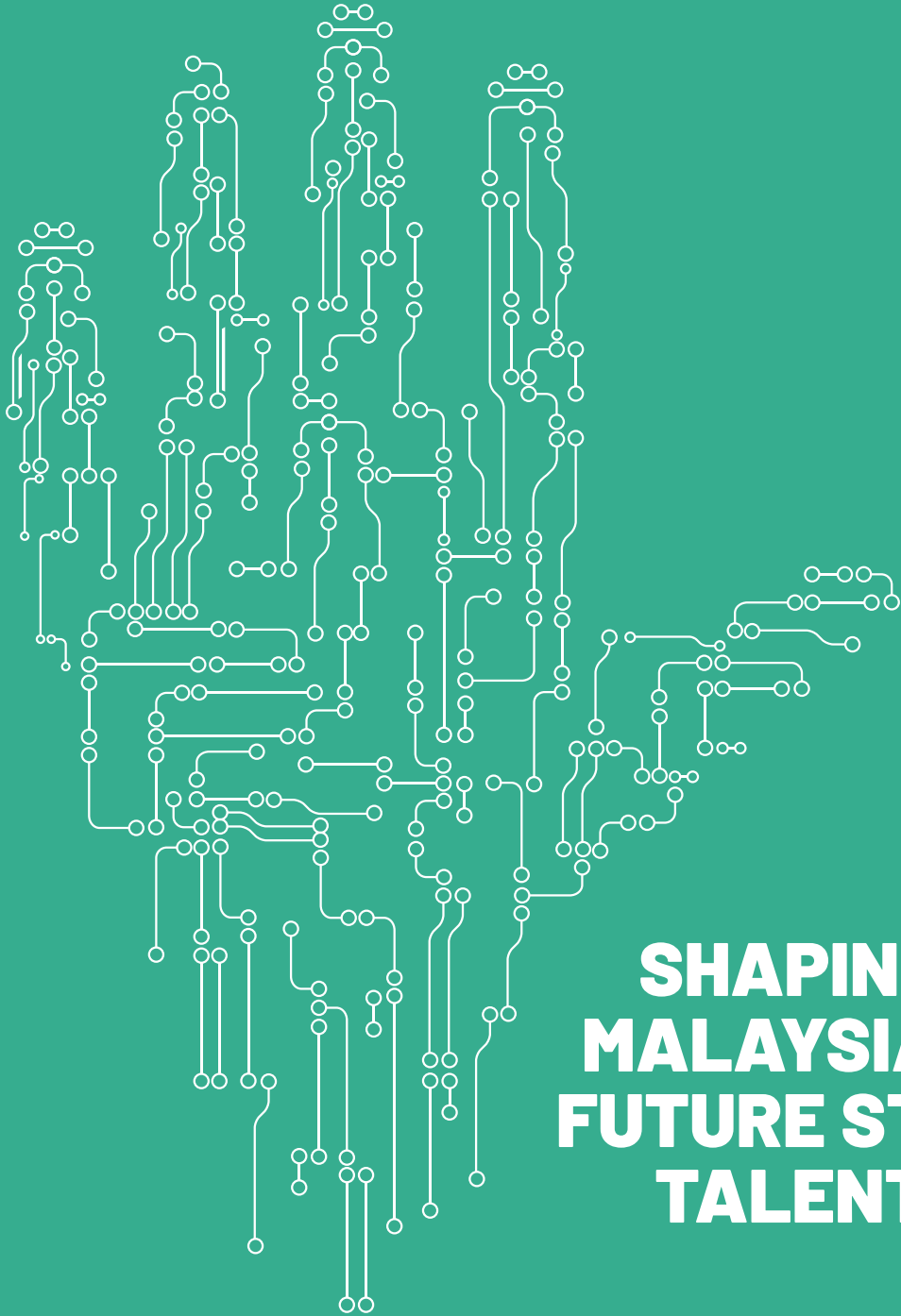


Among the 241 identified, the following 15 were prioritised for their potential to drive rapid innovation and economic value

- 1 Fully Autonomous Air Vehicle
- 2 Fully Autonomous Vehicle
- 3 Personalised Vaccine
- 4 Hydrogen Energy
- 5 Hyper-personalisation using AI
- 6 Biochip
- 7 Response System for Compound Disaster
- 8 Quantum Cryptography Communication Technology
- 9 AI Semiconductor Chip
- 10 Autonomous Working Robot
- 11 Small Nuclear Battery
- 12 Disaster Prediction
- 13 Carbon-neutral Fuel
- 14 Carbon Cycle Observation Technology
- 15 Cell Reprogramming Technology

These priority innovations indicate the areas most likely to drive rapid technological progress and demand specialised skills. They provide a useful reference for Malaysia's own foresight on future STEM talent development.

# CHAPTER 2



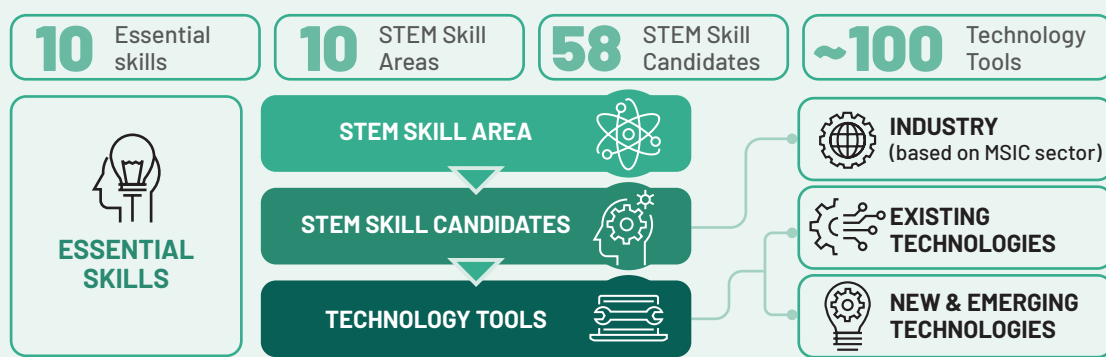
## **SHAPING MALAYSIA'S FUTURE STEM TALENT**

# SHAPING MALAYSIA'S FUTURE STEM TALENT

Malaysia's future skills needs lie at the intersection of where technologies are advancing and where industries are investing. The Nation's aspiration to become a high-income, innovation-driven economy depends on anticipating and cultivating the specialised competencies required by tomorrow's industries. There are many STEM areas and skills available, but their potential applications vary significantly according to industries, etc. Therefore, it is essential to identify and prioritise those that can contribute to Malaysia's future economic value.

This chapter introduces the STEM Skills Framework developed for the study, which comprises ten priority STEM areas, fifty-eight STEM skill candidates and over one hundred enabling technology tools as well as ten essential skills that are critical in ensuring a holistic STEM talent (Figures 2.1, 2.2 and 2.3). The framework provides the foundation for a systematic review of each STEM area, offering decision-makers a clear view of emerging demands and strategic priorities.

The foundation of this taxonomy is built on the following core elements:



## What terminology is used in the taxonomy?



### Essential Skills

Non-technical skills and competencies that complement STEM skills.



### STEM Skill Area

Refers to a broad category of related STEM skills that are grouped based on their application in specific industries or technology divisions. The groupings are based on the NEC code.



### STEM Skills

Belong to the group of technical skills based on the integration of the disciplines of science, mathematics, engineering and technology. They are a combination of the ability to produce scientific knowledge, supported by mathematical skills, in order to design and engineer technological and scientific products or services.



### Technology tool

A technology software and/or hardware that are utilised together with STEM skills to perform specialised tasks, solve complex problems, and drive innovation in technical fields.

Figure 2.1 STEM skills framework developed for future STEM talent in Malaysia.



Figure 2.2.10 STEM skill areas with 58 STEM skills identified for future STEM talent in Malaysia.



Figure 2.3 147 New and emerging technologies identified for future STEM talent in Malaysia.



## APPLIED SCIENCES AND TECHNOLOGY

### Bioinformatics

- DNA Data Storage
- Portable DNA Sequencer

### Biotechnology

- Alternative-protein Production
- Bioremediation
- Wastewater Bioplastic
- Genomic Vaccines
- Cell Therapy 2.0 (Innate Immune Cells, Precision Control of Cell Therapy, in Vivo Cell Therapy)
- Programmable Cells
- Cytotoxic Therapeutic
- Stabilised mRNA Therapeutics

### Food Technology

- Edible Packaging
- Active Packaging

### Geoinformation

- Geospatial Artificial Intelligence

### Geomatics

- Hyperspectral Imaging

### Material Sciences and Technology

- Self-Healing Materials
- Elastocalorics
- Solar Glass
- Biobased Materials
- Quantum Compass
- Circular Batteries
- Carbon-Cement Supercapacitor
- Solid State Lithium-Ion Battery
- Biosensor
- Metamaterials
- Mycological Biopolymers
- Graphyne
- Carbon Nanotube
- Advanced Composite Materials
- High Performance Thermoplastics
- Superhydrophobic Coatings
- Auxetic Material

### Medical Technology

- Health Monitoring Skin Patch
- Implantable Sensor
- Medical Nanobot
- Medical Tricorder
- Brain Chip Implant

### Information and Communication Technology

- Generative AI
- Federated Machine Learning
- Responsible AI
- AI Mentor
- Machine Vision
- Edge Cloud Computing
- Neuromorphic Computing
- Quantum Computing
- Quantum Communication
- Quantum Key Distribution / Quantum Security
- Quantum Sensing
- Edge Computing
- Spatial Computing
- Predictive Maintenance
- Synthetic Data
- Metro edge / High Performance Data Storage and Data Centers
- Zero-trust Architecture
- Cybersecurity Mesh Infrastructure
- IoT Device Edge
- Wi-Fi 6 and 7
- 6th-Generation Wireless
- High-altitude Platform Systems
- Direct-to-handset Satellite Connectivity
- Industrial Internet of Things
- Mobility as a Service
- Low- and No-code Platforms
- Microservices and Application Programming Interfaces
- Blockchain of Things
- Web 3.0
- Middleware
- Proof-of-Stake Blockchain
- Augmented Reality
- Virtual Reality
- Mixed Reality
- Digital Twins
- AR Workforce Assistance
- Industrial Metaverse
- Cognitive Twin



## EARTH SCIENCES

### Environmental Sciences and Management

- Autonomous Sustainability Monitoring
- Carbon Dioxide Extractor Array



## SOCIAL SCIENCES

### Education

- Sensing Classroom
- Smart Classroom



For detailed methodology and results, refer to Appendix C: Identification of New and Emerging Technology Candidates  
D: List of New and Emerging Technology Candidates

Figure 2.3 147 New and emerging technologies identified for future STEM talent in Malaysia.

## IDENTIFYING STEM SKILL AREAS THAT WILL SHAPE MALAYSIA'S FUTURE STEM TALENT

### SKILLS CONCENTRATE WHERE TECHNOLOGY PUSH MEETS INDUSTRY PULL

Malaysia's needs are not evenly spread. They cluster where fast-moving technologies meet active adoption by firms. As shown in Figure 2.4 that maps the technology push and demand pull from industries, larger nodes of STEM skill areas denote fields that are strongly advanced by technology and widely demanded by industry. Repeatedly, the centre of the network features Artificial Intelligence and Data Technologies, Smart Systems and Digital Transformation, Environmental and Sustainability, Digital Security and Cyber Defence, Computational and Physical Sciences, Energy and Engineering Infrastructure and Strategic Planning and Risk Management. These STEM skill areas are not narrow niches. They are platform capabilities that other activities build on.

### TECHNOLOGY PUSH SETS THE PACE OF CHANGE

Digital, intelligent and green technologies set the pace for technology push as momentum is strongest in intelligent and connected systems, supported by cloud and edge platforms, data infrastructure and responsible AI practices. This raises demand in STEM skill areas for Artificial Intelligence and Data Technologies and in Smart Systems and Digital Transformation and places a premium on algorithmic thinking, data engineering and secure system design. In parallel, green and materials innovation is reshaping energy, mobility, agriculture and manufacturing. That pushes requirements in Environmental and Sustainability, Energy and Engineering Infrastructure, Materials Science and Advanced Manufacturing and Computational and Physical Sciences. Together, these shifts explain why these STEM skill areas sit at the centre of the technology map and why they underpin so many downstream applications.

### DEMAND PULL SHAPES DEPTH AND TIMING

On the demand side, plausible futures for Malaysia point to data-rich learning systems, robotics-enabled manufacturing, sustainability-led supply chains and genomics-driven healthcare. These contexts determine how quickly skills are needed and what depth is required. Factories emphasise Smart Systems and Digital Transformation and Materials Science and Advanced Manufacturing STEM skill areas. The energy system prioritises Energy and Engineering Infrastructure and Environmental and Sustainability. Services and government rely on Digital Security and Cyber Defence together with Strategic Planning and Risk Management to ensure trust and accountability. Health and life sciences strengthen Healthcare and Biomedical Sciences, while Food Security and Agricultural Systems combine precision methods with sustainability and logistics. Megatrends in technological transformation, demographics, climate action, economic headwinds and governance needs reweight this mix over time and underline the importance of resilient, ethically governed adoption.

### DELPHI PRIORITISATION REVEALS MALAYSIA'S CURRENT READINESS AND POTENTIAL RETURNS

The prioritisation of the 58 STEM Skills within the 10 STEM Skill Areas clarifies where Malaysia can realise the greatest returns and how quickly those returns are achievable. The Delphi survey evaluates the STEM skills based on:



#### Attractiveness

the degree to which the skill supports Malaysia's economic growth, global competitiveness and industrial advancement.



#### Feasibility

the ease with which Malaysia can develop and deploy the skill within its workforce, considering education systems and ecosystem readiness.

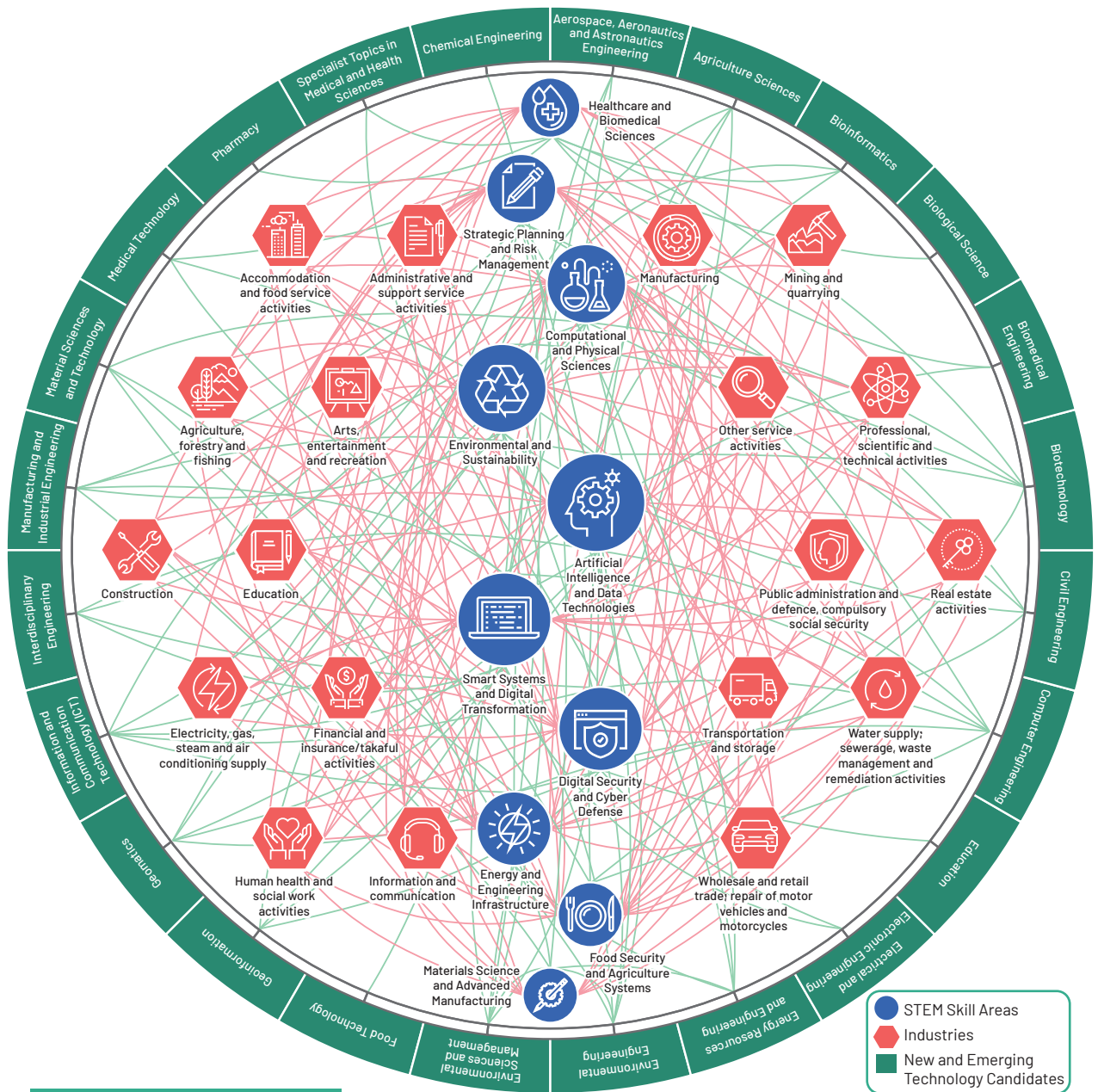


Figure 2.4 Where technology push meets industry pull: a linkage map of STEM Skill Areas.



## What is Delphi methodology?

The Delphi methodology was used to gather expert insights and build consensus on the prioritisation of STEM skills most critical to Malaysia's future economic value. It involves conducting expert surveys in two rounds, where participants review the results from earlier round before providing revised feedback. This structured process combines both qualitative and quantitative perspectives, making it particularly suitable for exploring complex and future-oriented issues such as identifying emerging skills. Using this approach, the study evaluated the attractiveness and feasibility of the identified STEM skills, ensuring that the final prioritisation reflects current realities while also addressing Malaysia's future economic growth, workforce needs and global competitiveness.



For detailed methodology and the results of the two-round Delphi survey, refer to Appendices E and F.

From the Delphi prioritisation, a clear centre of gravity emerges. Artificial Intelligence and Data Technologies, Smart Systems and Digital Transformation, Digital Security and Cyber Defence, Environmental and Sustainability and Strategic Planning and Risk Management form a high-priority backbone of STEM Skill Areas (Figure 2.5). These areas combine strong technology momentum with wide industry demand and their underlying skills are consistently rated highly attractive. Feasibility is generally moderate, pointing to capability gaps that can be addressed through educator development, applied learning and shared digital and research platforms.

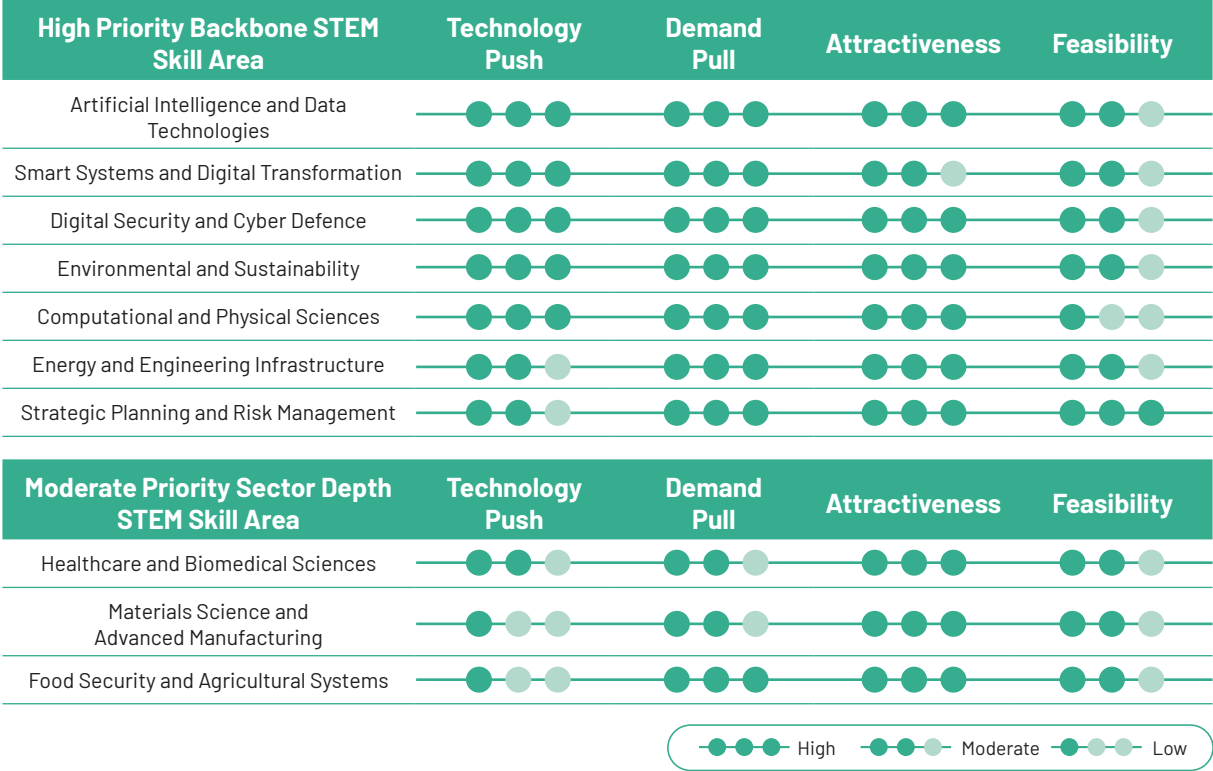


Figure 2.5 Prioritisation of the STEM Skill Areas.

Energy and Engineering Infrastructure and Computational and Physical Sciences sit close to this backbone. Energy and Engineering Infrastructure is strongly supported by demand and ready for scaling in line with national missions. Computational and Physical Sciences remains essential for modelling and analytical depth, although several specialist skills are still maturing. A pilot-first approach, anchored in computational modelling and simulation, will help convert potential into practice.

Healthcare and Biomedical Sciences, Materials Science and Advanced Manufacturing and Food Security and Agricultural Systems provide sector depth. Their skills are attractive and align with Malaysia’s production structure, yet readiness varies. These STEM Skill Areas benefit from

targeted programmes that link campuses, shared laboratories and industry placements so that capability grows in step with adoption and regulatory preparedness.

**WHAT THIS MEANS FOR MALAYSIA**

Malaysia can use this priority map to sequence action. The high-priority backbone should anchor curriculum renewal, professional development for educators and the build-out of common digital and research infrastructure. Doing so raises quality across programmes and creates pathways that matter to most industries. Energy and Engineering Infrastructure and Computational and Physical Sciences should advance in parallel where they support national missions and the analytics that underpin safe, efficient deployment.

Sector-depth areas convert capability into jobs and value in specific parts of the economy. Healthcare and Biomedical Sciences, Materials Science and Advanced Manufacturing and Food Security and Agricultural Systems will benefit from mission-linked projects, shared facilities for testing and compliance and stronger translational links between research groups and firms. Where feasibility is uneven, begin with modules and placements that mirror real work, then scale as adoption and capacity increase.

This approach keeps the talent pipeline responsive to fast technology cycles while grounded in Malaysia’s economic structure and national ambitions to 2040. It concentrates early effort where cross-cutting returns are largest and preserves a clear path to deepen capability in priority sectors.

## 2.2 DEEP DIVING INTO STEM SKILLS THAT WILL SHAPE MALAYSIA’S FUTURE STEM TALENT

### WHY GO BEYOND STEM SKILL AREAS

While STEM Skill Areas can form the foundational blocks for planning, decisions on curricula, hiring, equipment and funding are made at the level of skills. A deeper view translates broad areas into the specific competencies that educators teach, employers recruit for and agencies support. This section therefore moves from the 10 STEM Skill Areas to the 58 individual STEM Skills that drive performance on the ground. An expert assessment was undertaken to assess the 58 STEM Skills via a 2-round Delphi Survey as previously mentioned to provide a snapshot and insights to prioritise the STEM Skills via the Attractiveness-Feasibility matrix into 5 groups (Table 2.1).

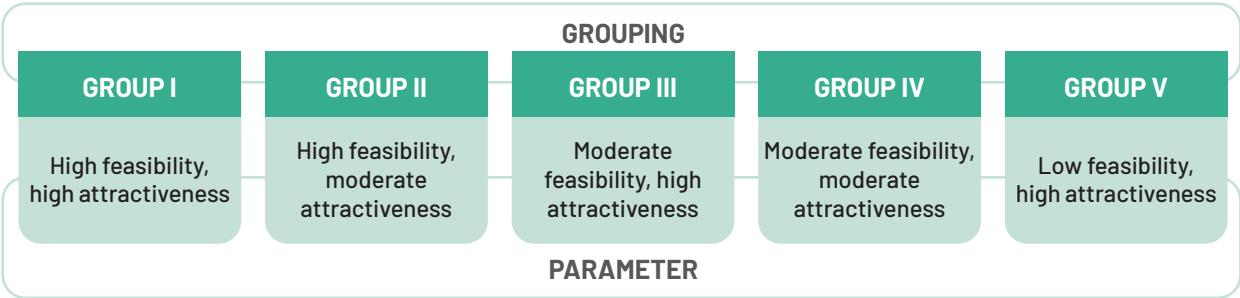


Table 2.1 Prioritisation of the STEM Skills via Attractiveness-Feasibility resulted in 5 distinct groups of STEM Skills for action.

### WHAT THE PRIORITISATION SHOWS

The results from the Delphi survey prioritising the STEM Skills points to a clear message.

STEM Skills that fall into Group I (High Attractiveness + High Feasibility), are both highly attractive for Malaysia’s future economic value and realistically achievable within the current ecosystem. They are aligned with national priorities, demonstrate strong industry demand and can be developed with existing infrastructure, talent pipelines and policy support. As such, these skills represent immediate priorities for investment, policy focus and talent development, as they are expected to deliver significant and timely returns to Malaysia’s economic value.

The largest share of prioritised STEM Skills is in Group III (High Attractiveness + Moderate Feasibility). This pattern indicates strong economic payoffs once practical bottlenecks are cleared. Typical constraints include access to specialist tools and datasets, limited opportunities for supervised practice, shortages of experienced mentors, uneven assessment standards and slow approval cycles for updated programmes. Many of these skills are emerging at the junction of disciplines, so integration across curricula, accreditation and workplace learning is still catching up.

Prioritisation informs policymakers where to concentrate enablement. STEM Skills in Group III are a near to medium term opportunity. With focused enablement, many of these skills can move into Group I within two to five years. These skills already have market pull and strategic relevance.

Targeted infrastructure, pedagogy, standards and placements convert that potential into scalable capability and measurable value. Actions could include building shared platforms and testbeds, including data resources and secure compute. Expand applied projects and work-integrated learning so learners can practise with real systems. Invest in train-the-trainer pathways and master teacher tracks to spread capability quickly. Issue clear competency standards and recognise micro-credentials. Use regulatory sandboxes for areas such as AI, cyber and medical-adjacent technologies so practice and assurance grow together or form employer consortia to articulate skill profiles and guarantee placements

and strengthen language readiness where global materials and collaboration are essential.

Beyond the backbone of Groups I and III, the remaining groups play distinct roles in a balanced portfolio. Group II skills, with high feasibility and moderate attractiveness, are fast, low-friction enablers that shore up resilience, compliance and delivery quality across sectors. Group IV, with moderate feasibility and moderate attractiveness, offers limited near-term returns unless delivery is reframed in applied contexts. These skills warrant a targeted refresh and closer integration with higher-impact domains rather than standalone expansion. Group V combines low feasibility with high attractiveness. The strategic promise is clear, yet capability, cost and scale remain binding constraints. Treat these as long-horizon options, advancing through focused pilots, international partnerships and time-bound reviews so investment stays proportionate while Malaysia remains positioned for future breakthroughs (Figure 2.6).

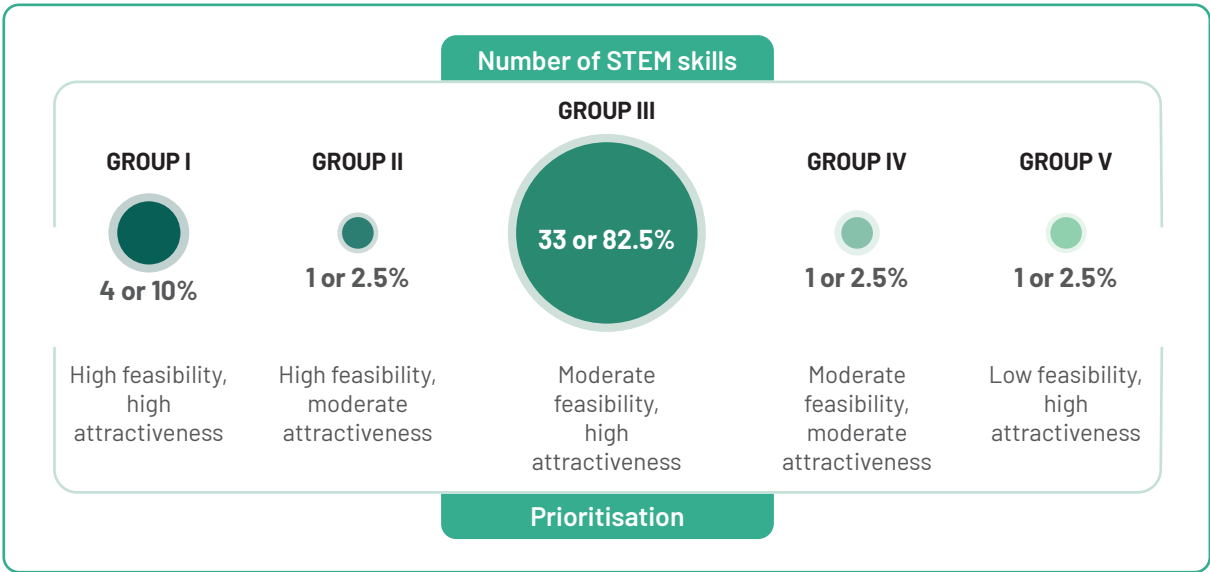
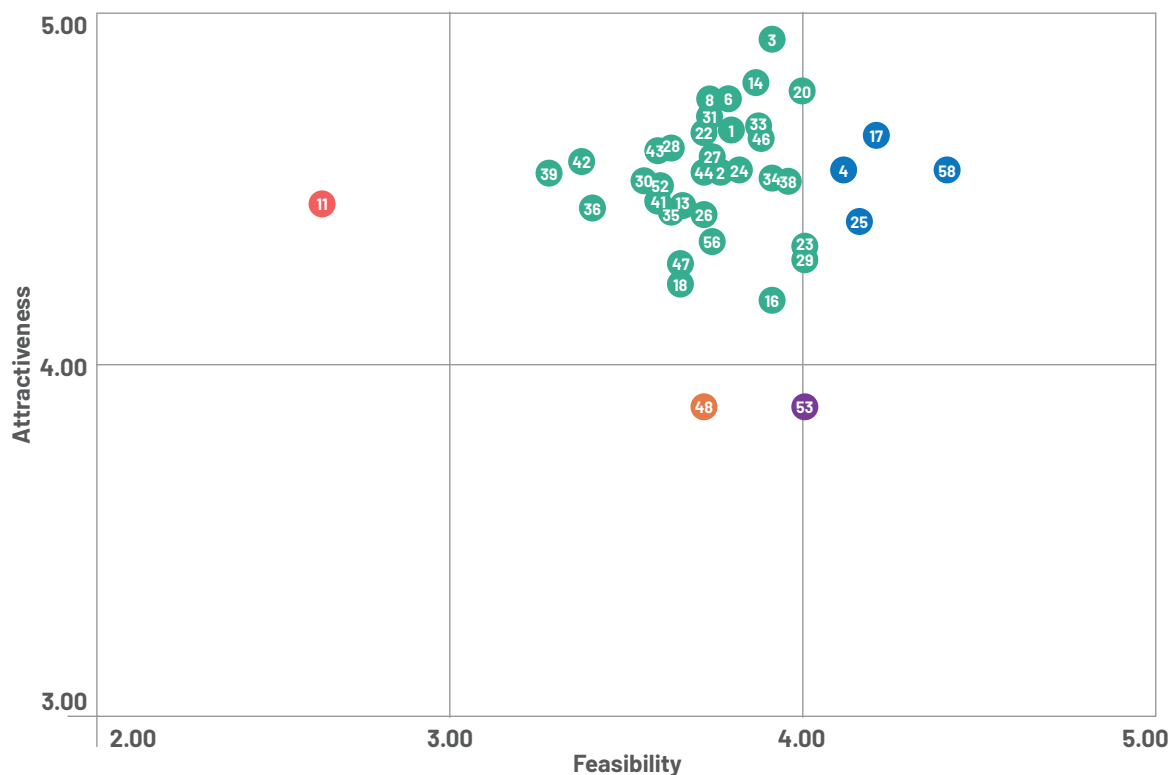


Figure 2.6 Distribution of prioritised STEM Skills according to 5 groups.

The results are shown in Figure 2.7 which captures the full landscape of assessed skills based on the Attractiveness versus Feasibility parameter, while Figure 2.8 lists the 40 STEM Skills that met the study’s threshold for prioritisation while 18 STEM Skills that did not meet the minimum threshold for prioritisation was therefore not prioritised (Figure 2.9).

## Attractiveness-Feasibility of STEM skills for future economic value



### GROUP I: HIGH FEASIBILITY, HIGH ATTRACTIVENESS

- 4 Data Analytics & Visualisation
- 17 Advanced Installation, Maintenance & Reliability Engineering
- 25 Environmental Management
- 58 Workplace Safety & Health Management

### GROUP II: HIGH FEASIBILITY, MODERATE ATTRACTIVENESS

- 53 Emergency & Disaster Preparedness

### GROUP IV: MODERATE FEASIBILITY, MODERATE ATTRACTIVENESS

- 48 Programming & Coding

### GROUP V: LOW FEASIBILITY, HIGH ATTRACTIVENESS

- 11 Quantum Science & Engineering

### GROUP III: MODERATE FEASIBILITY, HIGH ATTRACTIVENESS

- |   |  |
|---|--|
| <ul style="list-style-type: none"> <li>1 Artificial Intelligence &amp; Machine Learning Modelling</li> <li>2 Applied Data Science</li> <li>3 Cloud Computing</li> <li>6 Generative AI &amp; Large Language Modelling</li> <li>8 Computational Modelling &amp; Simulation</li> <li>13 AI Governance</li> <li>14 Cybersecurity</li> <li>16 Network &amp; Computer Systems Administration</li> <li>18 Civil &amp; Structural Engineering Management</li> <li>20 Electrical &amp; Electronics Systems</li> <li>22 Mechatronic Systems Integration &amp; Design</li> <li>23 Process &amp; Automation Control</li> <li>24 Renewable Energy Systems Engineering</li> <li>26 Geospatial Analytics</li> <li>27 Green Chemistry &amp; Sustainability</li> <li>28 Life Cycle Assessment</li> <li>29 Waste &amp; Hazardous Material Management</li> </ul> | <ul style="list-style-type: none"> <li>30 Agriculture Management</li> <li>31 Food Engineering &amp; Processing</li> <li>33 Precision Agriculture</li> <li>34 Sustainable Farming</li> <li>35 Biomedical Product Development &amp; Engineering</li> <li>36 Clinical &amp; Medical Practice</li> <li>38 Good Laboratory Practice Management</li> <li>39 Multi-omics Integrated Analysis</li> <li>41 Pharmaceutical Sciences</li> <li>42 Synthetic Biology</li> <li>43 Advanced Materials Engineering</li> <li>44 Material Science</li> <li>46 Embedded Systems Development</li> <li>47 IoT Systems &amp; Applications</li> <li>52 Applied Research &amp; Development Management</li> <li>56 Strategic Technology Planning</li> </ul> |
|---|--|

### 18 STEM SKILLS NOT PRIORITISED

- 5 Data Engineering
- 7 Aerospace Systems Maintenance & Integration
- 9 Kinematic Modelling
- 10 Mathematical And Statistical Modelling
- 12 Space Systems Engineering
- 15 Data Governance
- 19 Digital & Control Systems Engineering
- 21 Marine & Offshore Engineering
- 32 One Health & Zoonotic Disease Management
- 37 Diagnostic & Imaging Expertise
- 40 Patient-centered Services
- 45 Surface & Packaging Engineering
- 49 Software Development & Testing
- 51 UX Engineering
- 54 Energy Trading & Hedging Strategies
- 55 Quality, Health, Safety & Environment Compliance
- 57 Technology Risk Management

Figure 2.7 Prioritisation of the STEM Skill according to the Attractiveness-Feasibility Matrix via a 2-round Delphi Survey.

## 40 STEM Skills That Were Prioritised



### Artificial Intelligence & Data Technologies

1. Artificial Intelligence & Machine Learning Modelling
2. Applied Data Science
3. Cloud Computing
4. Data Analytics & Visualisation
6. Generative AI & large language modelling
7. Large Language Modelling



### Computational & Physical Sciences

8. Computational Modelling & Simulation
11. Quantum Science & Engineering



### Digital Security & Cyber Defence

13. AI Governance
14. Cybersecurity
16. Network & Computer Systems Administration



### Energy & Engineering Infrastructure

17. Advanced Installation, Maintenance & Civil Structural Engineering
18. Electrical & Electronics Engineering
20. Electrical & Electronics Systems
22. Mechatronic Systems Integration & Design
23. Process & Automation Control
24. Renewable Energy Systems Engineering



### Environmental & Sustainability

25. Environmental Management
26. Geospatial Analytics
27. Green Chemistry & Sustainability
28. Life Cycle Assessment
29. Waste & Hazardous Material Management



### Food Security & Agriculture Systems

30. Agriculture Management
31. Food Engineering & Processing
33. Precision Agriculture
34. Sustainable Farming



### Healthcare & Biomedical Sciences

35. Biomedical Product Development & Engineering
36. Clinical & Medical Practice
38. Good Laboratory Practice Management
39. Multi-omics Integrated Analysis
41. Pharmaceutical Sciences
42. Synthetic Biology



### Materials Science & Advanced Manufacturing

43. Advanced Materials Engineering
44. Material Science



### Smart Systems & Digital Transformation

46. Embedded Systems Development
47. IoT Systems & Applications
48. Programming & Coding



### Strategic Planning & Risk Management

52. Applied Research & Development Management
53. Emergency & Disaster Preparedness
56. Strategic Technology Planning
58. Workplace Safety & Health Management

Figure 2.8 40 STEM Skills that were prioritised from the 2-round Delphi Survey.

## 18 STEM Skills That Were Not Prioritised

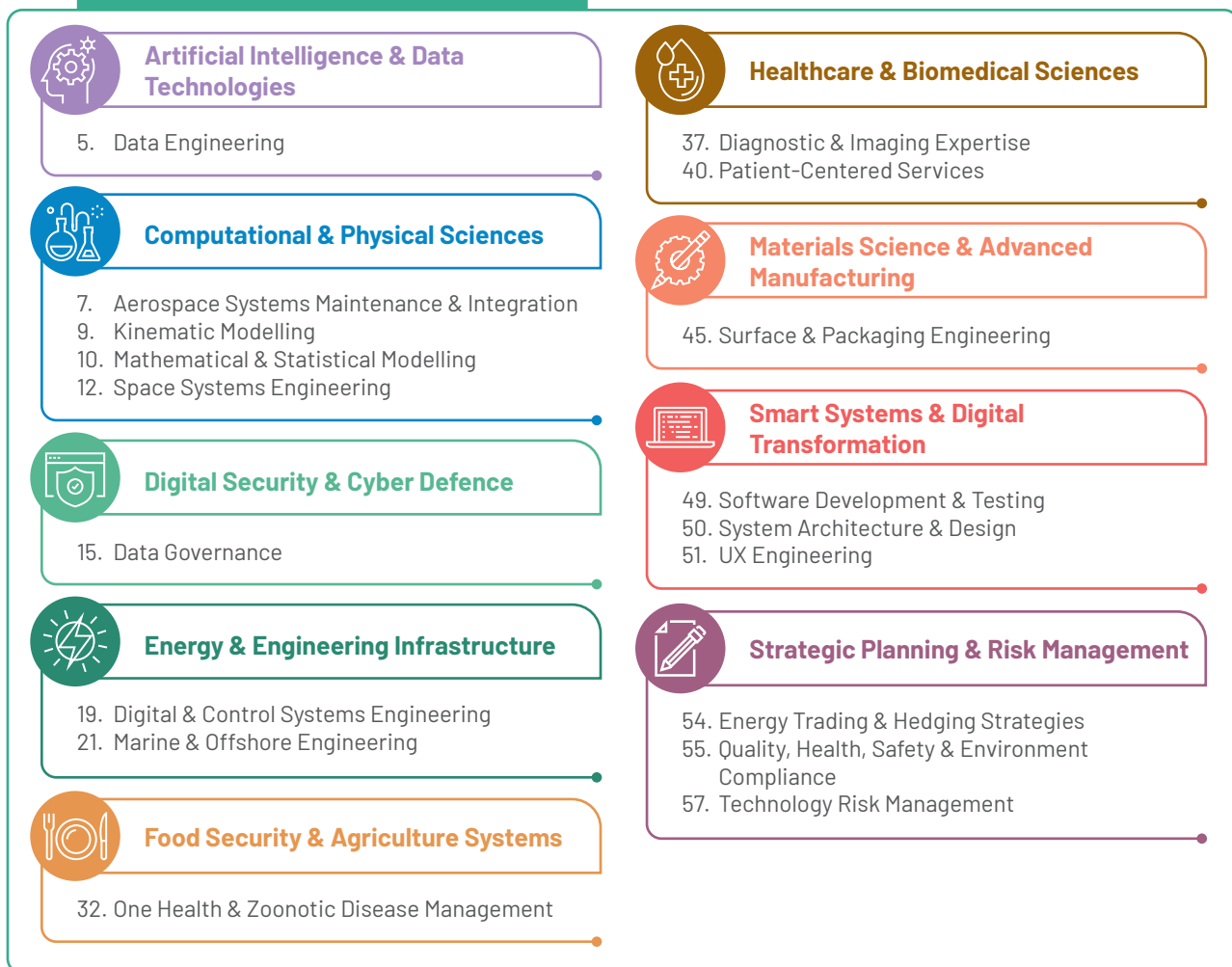






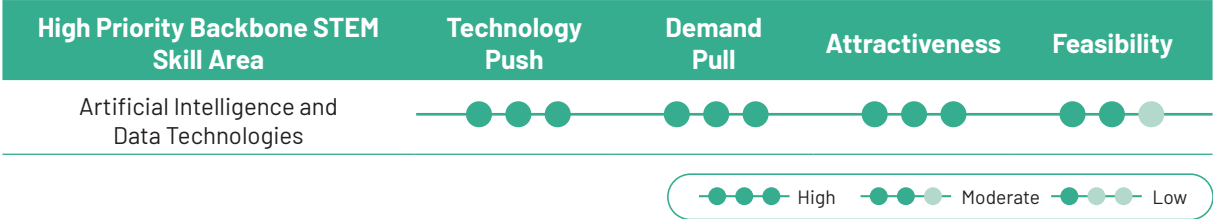
Figure 2.9 STEM Skills that were not prioritised from the 2-round Delphi Survey.

### Why the 18 not prioritised STEM Skills likely had lower sample size:

- 
**Narrow or emerging expert pools in Malaysia:** space systems engineering, aerospace systems maintenance and integration, marine and offshore engineering, energy trading and hedging, and diagnostic imaging have fewer local specialists.
- 
**Horizontal or “business-as-usual” labels that panellists may think are already covered:** data engineering, data governance, software development and testing, UX engineering, QHSE compliance, patient centred services.
- 
**Overlap and terminology:** kinematic modelling versus mathematical and statistical modelling, and digital and control systems engineering can be read as subsets of automation or robotics, leading to skips.
- 
**Sector skew:** stronger participation from E&E, academia and government, thinner from hospitals, trading desks, offshore services, UX-heavy product firms.
- 
**Commercial sensitivity:** energy trading and hedging, diagnostic imaging partnerships, and technology risk practices can deter detailed responses.
- 
**Item load and fatigue:** later items in a long list attract fewer confident ratings.

The following sections deep dive into each STEM Skills within the 10 STEM Skill Areas for better contextualisation. For every area, the analysis explains national significance, expected shifts in employment and likely economic effects, then outlines the prioritised STEM skills and why each matters. The purpose is practical. Policymakers can see where to invest, educators can align curricula and assessment and employers can shape recruitment, apprenticeships and upskilling to match the skills that will create value for Malaysia to 2040.

## 2.2.1 ARTIFICIAL INTELLIGENCE AND DATA TECHNOLOGIES



### WHAT IS IT?

Artificial Intelligence & Data Technologies is a broad STEM area that integrates advanced computing, data analytics and intelligent systems to develop solutions capable of learning, adapting and making decisions.

STEM Skills under Artificial Intelligence and Data Technologies sit at the centre of Malaysia’s skills map. Technology development is advancing quickly and industry appetite is wide, placing this area high on both push and pull. Attractiveness is high because gains compound across sectors; feasibility is high to moderate, with analytics and cloud already deployable at scale while model development at enterprise level depends on access to compute, high-quality datasets and disciplined governance.

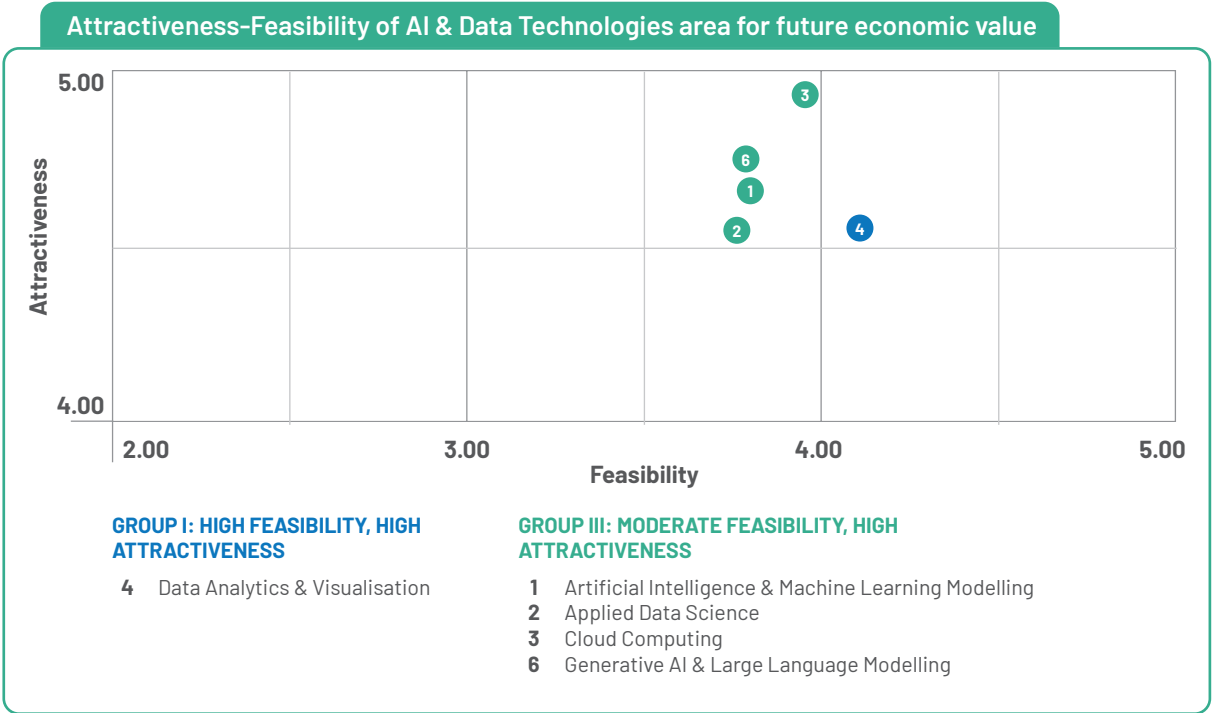


Figure 2.10 Prioritised AI and Data Technologies skills

STEM SKILL	PRIORITISATION	ATTRACTIVENESS	FEASIBILITY
Data Analytics and Visualisation	Group I (High Feasibility + High Attractiveness)	The demand for this STEM skill is expected to grow significantly, driven by advancements in AI, IoT and Industry 4.0, as well as the increasing reliance on data-driven decision-making across sectors such as finance, healthcare, logistics and manufacturing.	Existing ecosystem bolstered by national initiatives allows adoption of this STEM skill in industries through infrastructure, training and government support. While adoption is growing, broader uptake will require continued investment in upskilling, infrastructure and digital literacy to ensure readiness across all industry segments.
Artificial Intelligence and Machine Learning Modelling	Group III (Moderate Feasibility + High Attractiveness)	Ability to enhance Malaysia's productivity by automating complex tasks, enabling predictive analytics and streamlining decision-making across various industries.	Existing ecosystem bolstered by national strategies provides a foundation for the adoption of this STEM skill across industries. However, full-scale implementation is required to close remaining gaps.
Applied Data Science		As a cross-cutting STEM skill, it drives economic growth by creating high-value jobs, attracting investments and supporting innovation, making Malaysia more competitive in the global digital economy.	Existing ecosystem provides a basic foundation for the adoption of this STEM skill, supported by government initiatives, industry interest and some institutional efforts. However, widespread adoption is limited by gaps in infrastructure, skilled talent, public awareness and collaboration
Cloud Computing		Cloud computing is strongly aligned with the needs of new and emerging industries in Malaysia, driving digital transformation in sectors such as finance, healthcare, manufacturing, e-commerce, education and government services.	Malaysia's ecosystem already supports cloud adoption, with major global providers establishing data centres or partnerships and driving growth in local infrastructure. However, to enable adoption across the industry landscape, more data centres and upgrades in connectivity, especially in rural areas are needed.
Generative AI and Large Language Modelling		As Generative AI and Large Language Modelling technologies become central to business and government operations, they boost productivity, attract foreign investment and position Malaysia as a competitive hub in the global digital economy.	The adoption of this STEM skill in Malaysia is moderately feasible now, as many industries especially SMEs face challenges such as limited digital infrastructure, budget constraints and a shortage of skilled professionals.
Data Engineering	Not prioritised	Data engineering was not identified as one of the prioritised skills contributing directly to Malaysia's future economic value, possibly because it is often regarded as a supporting or enabling function rather than a high-impact driver on its own (Data Science Institute, 2025). While it does not deliver immediate, visible outcomes like AI modelling or data analytics, data engineering plays a critical role in building and maintaining the infrastructure that makes these applications possible. Its contribution is therefore indirect but essential, ensuring that data pipelines, integration systems and storage frameworks are reliable and efficient to support the success of higher-priority AI and data-related skills.	

## WHY IT MATTERS FOR MALAYSIA?

The AI and Data Technologies ecosystem is pivotal to Malaysia's journey toward a high-income, innovation-driven economy. These technologies enhance productivity, optimise processes and enable new business models across key sectors such as manufacturing, healthcare, agriculture, logistics and finance fully aligned with the goals outlined in the MyDIGITAL Blueprint, which positions digital technologies as foundational for economic competitiveness and inclusive growth. On the employment front, AI and data are reshaping the labour market by automating routine tasks and creating high-demand roles in data science, machine learning, cloud computing, AI governance and cybersecurity. While some job displacement is expected, studies demonstrate that AI often enhances work quality and productivity especially for lower-skilled workers for example, by improving issue resolution speed and service quality by up to 15% in certain roles.

### AI and data will anchor productivity, innovation and service quality

AI and data capabilities enable real-time decisions, automation and personalisation across manufacturing, services and the public sector. Well-governed adoption shortens time to market, improves first-pass yield, lowers energy and transport costs and raises service productivity. Local capability in adapting models to Bahasa Malaysia and sector vocabularies reduces reliance on imported, one-size-fits-all solutions, enabling exportable digital offerings and faster diffusion of Industry 4.0 practices. As a platform capability, this STEM Skill Area also lifts performance in adjacent domains such as Smart Systems and Digital Transformation, Digital Security and Cyber Defence, Environmental and Sustainability and Energy and Engineering Infrastructure.

### Employment will shift towards model-centric, cloud-enabled and governance roles

Routine reporting and manual data handling continue to decline as pipelines mature. Demand grows for applied data scientists, machine learning engineers, cloud practitioners, data visualisation specialists, AI governance and assurance professionals and hybrid roles that join statistics, software and domain expertise.

### Economic gains will come from higher productivity and faster diffusion

Shared datasets, secure networks and elastic compute shorten development cycles and allow many users to build on common rails. Organisations that embed analytics and trustworthy AI see faster improvement in quality, cost and service, which compounds when platforms are open to education providers, SMEs and public agencies.

### Potential negative impact

AI and Data Technologies, while essential for Malaysia's digital growth, pose several potential negative impacts across society, culture and the environment.

- Social risks include job displacement from automation, data misuse, privacy breaches and biased decision-making that could undermine trust and fairness.
- Culturally, the over-reliance on AI may erode human judgment, diminish creativity, reinforce stereotypes and promote homogenised digital practices at the expense of local values and traditions.
- Environmentally, the high computational demands of AI, large-scale data storage and cloud infrastructure drive significant energy use, carbon emissions and resource consumption.

These challenges underscore the urgent need for robust governance, ethical safeguards and sustainable technology practices to balance innovation with social responsibility and environmental stewardship.

## INCREASING FUTURE PREPAREDNESS

### Knowledge depth needed

Entry to professional practice is best built at MQF Level 6. Bachelor-level programmes should graduate practitioners able to design data pipelines, deploy analytics and operate cloud-based services securely. Postgraduate pathways at MQF Levels 7–8 develop innovators, researchers and leaders who can create novel models, govern high-risk applications and steer national adoption strategies in line with ethics and public value. This points to strengthening bachelor-level data and computing education, widening inclusive TVET access for foundational roles and using postgraduate specialisation to build leadership in AI invention, assurance and large-scale deployment.

### When the STEM Skills will be required

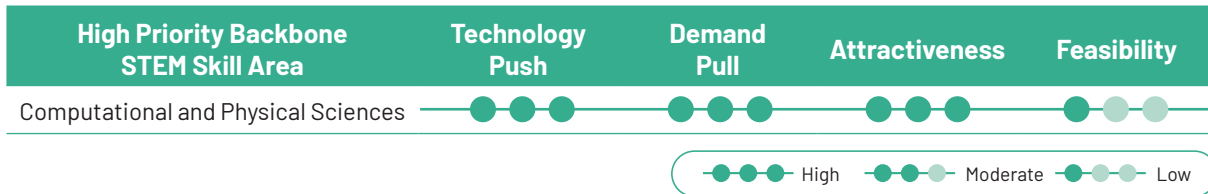
Core capabilities that include artificial intelligence and machine learning modelling, applied data science, cloud computing and analytics are needed now onwards and already warrant mass-market uptake across education and industry. Generative AI and large language models are moving rapidly from pilots to broader deployment; demand is expected to accelerate through the 2030s as domain-adapted models, safety tooling and efficient compute mature.



### Signals to watch

- Share of organisations embedding analytics in core processes
- Number of AI-enabled products launched by Malaysian firms
- Uptake of shared datasets, cloud credits and model-evaluation frameworks
- Measured productivity gains in manufacturing and services
- Export growth in AI-enabled offerings
- Improvements in public-sector service times

## 2.2.2 COMPUTATIONAL AND PHYSICAL SCIENCES



### WHAT IS IT?

Computational and Physical Sciences is a STEM skill area that combines advanced computing techniques with the principles of the physical sciences (such as physics, chemistry and material sciences) to solve complex real-world problems. It focuses on using computational methods, simulations and mathematical modelling to understand, predict and optimise physical processes, materials and systems.

#### Attractiveness–Feasibility of Computational & Physical Sciences area for future economic value

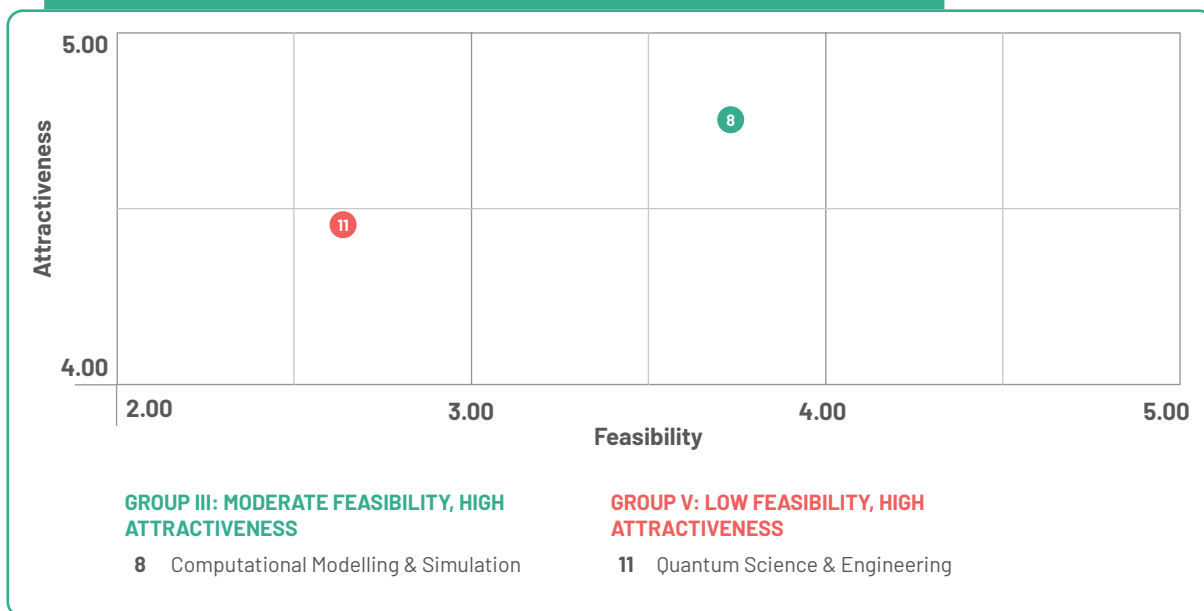


Figure 2.11 Prioritised Computational and Physical Sciences skills.

STEM SKILL	PRIORITISATION	ATTRACTIVENESS	FEASIBILITY
Computational Modelling and Simulation	Group III (Moderate Feasibility + High Attractiveness)	By mastering this skill, enables Malaysian industries to meet international standards by allowing precise design, testing and optimisation of products, particularly in high-tech sectors like semiconductors. Mastery of this STEM skill enhances product quality, reduces prototyping costs, supports innovation and positions Malaysia's industries to deliver high-value, globally competitive solutions.	Malaysia's existing ecosystem does support the adoption of this skill through established R&D institutions, higher education programs and an expanding digital infrastructure. However, to enable broader and more effective integration into industries, the ecosystem requires enhanced access to high-performance computing, stronger university-industry collaboration, increased awareness and alignment with international best practices.
Quantum Science and Engineering	Group V (Low Feasibility + High Attractiveness)	Quantum Science and Engineering skill is highly aligned with the needs of new and emerging industries, as it drives advancements in quantum hardware production, computing, sensing and communication that can boost sectors such as energy, aerospace, E&E, finance and healthcare.	Presently, Malaysia lacks quantum-related standards and has limited relevant industries, which makes the ecosystem less ready for broad adoption of Quantum Science and Engineering skill.
Aerospace Systems Maintenance and Integration	Not prioritised	While valuable in niche MRO (Maintenance, Repair & Overhaul) sectors, this skill remains specialised with limited national spillover compared to strategic areas like AI or renewable energy. Malaysia does possess capabilities in aerospace MRO benefiting from investments in clusters like Subang Aerotech Park but the scope and economic impact remain relatively narrow (MIDA).	
Kinematic Modelling		This skill supports robotics and motion sciences as a subset of broader modelling capacities. It was likely not prioritised at the national level due to its specificity, making it less of a stand-alone economic driver compared to skills with broader applicability.	
Mathematical and Statistical Modelling		Despite being foundational to many scientific and analytical processes, this skill is often seen as an enabling tool rather than a direct economic contributor. Its essential role underpins high-priority domains like AI or climate modelling but does not drive visible economic outcomes on its own.	
Space Systems Engineering		Malaysia is progressing in space capability development with entities like MYSA and MIGHT fostering collaboration, yet the ecosystem still lags in specialised infrastructure, talent and R&D capacity. While strategic, the feasibility of this skill remains low, placing it outside of immediate economic priority given current constraints (MIGHT, 2025).	

## WHY IT MATTERS FOR MALAYSIA?

Digital prototypes reduce reliance on costly trial-and-error and shorten development cycles in semiconductors, electronics, mobility, energy, infrastructure and health. Precision models improve first-pass yield, throughput and reliability and support compliance with international standards that govern safety and performance.

### High-value sectors depend on validated models to compete

As product complexity rises, competitive advantage is won in design, verification and process optimisation. Computational Modelling and Simulation (Skill 8, Group III) becomes a cross-cutting enabler for advanced manufacturing, energy systems planning, climate and environmental analysis and clinical research.

### Economic impact comes from faster cycles, lower risk and export readiness

Firms that institutionalise modelling and validation reduce prototyping waste, de-risk capital decisions and reach certification faster. Over time this strengthens participation in higher-margin segments and opens opportunities for exportable engineering services and digital-twin solutions.

Frontier capability in quantum is a longer-horizon option with strategic promise. Quantum Science and Engineering offers potential step-changes in sensing, communications and computation that are relevant to finance, health, aerospace and energy. Feasibility is currently constrained by talent depth, equipment and standards, so progress is best pursued through focused niches, partnerships and patient investment.

### Employment shifts toward simulation, verification and interdisciplinary practice

Demand grows for applied physicists, computational scientists and engineers who can build and validate models, run sensitivity and uncertainty analyses and translate findings into manufacturable designs. The work is increasingly interdisciplinary, blending domain science with numerical methods, software toolchains and data.

### Potential negative impact

Computational Modelling and Simulation and Quantum Science and Engineering, while vital for advancing Malaysia's STEM capabilities, carry significant risks if not carefully managed.

- In society, they may cause job displacement, widen the digital divide, or undermine trust and security particularly with quantum's potential to break current encryption systems and shift geopolitical power.
- Culturally, both areas risk eroding traditional knowledge, fostering overreliance on digital or abstract systems and prioritising profit or power over ethical reflection and human values.
- Environmentally, their heavy energy demands, reliance on specialised infrastructure and potential for e-waste or unforeseen systemic impacts highlight sustainability concerns. These challenges underscore the need for ethical governance, inclusive innovation and sustainable practices alongside technological progress.

## INCREASING FUTURE PREPAREDNESS

### Knowledge depth needed

Computational and Physical Sciences represent some of the most academically demanding STEM domains, with Computational Modelling and Simulation requiring mastery from the Bachelor's to Doctoral levels and Quantum Science and Engineering demanding Doctoral-level expertise as the gold standard. While lower-level qualifications may provide limited entry points, true mastery of these fields depends on advanced tertiary education and research capacity. This underscores the need for Malaysia to strengthen its postgraduate and research pathways to build a robust talent pipeline and secure long-term competitiveness in these critical areas.

### When the STEM Skills will be required

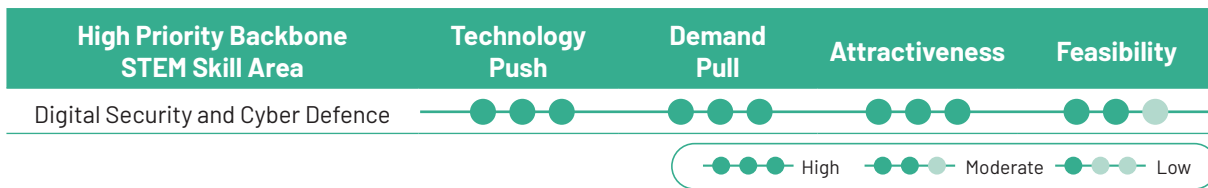
Computational Modelling and Simulation is needed now across priority sectors and should be scaled as a standard part of design and process engineering. Quantum Science and Engineering is a 2030-and-beyond capability, with early pilots and partnerships in the near term and broader application toward 2040 as talent, tools and standards mature.



### Signals to watch

- Share of engineering programmes and firms using validated models and digital twins in core workflows
- Time and cost reduction from model-led design compared with physical prototyping baselines
- Utilisation of high-performance computing for industrial and research modelling workloads
- Number of certified practitioners and postgraduate completions in modelling and simulation
- Quantum collaboration footprints, including joint projects with leading international labs and participation in standards initiatives

## 2.2.3 DIGITAL SECURITY AND CYBER DEFENCE



### WHAT IS IT?

Digital Security and Cyber Defence refers to the interdisciplinary domain focused on protecting digital systems, networks, data and infrastructure against unauthorised access, malicious attacks and other digital threats. It encompasses proactive defence strategies, governance and operational measures that ensure mission integrity, system resilience and information confidentiality. This skill area integrates technical expertise in cybersecurity, AI governance, data governance and IT systems administration, aiming to safeguard both digital assets and the responsible deployment of emerging technologies.

#### Attractiveness–Feasibility of Digital Security & Cyber Defence area for future economic value

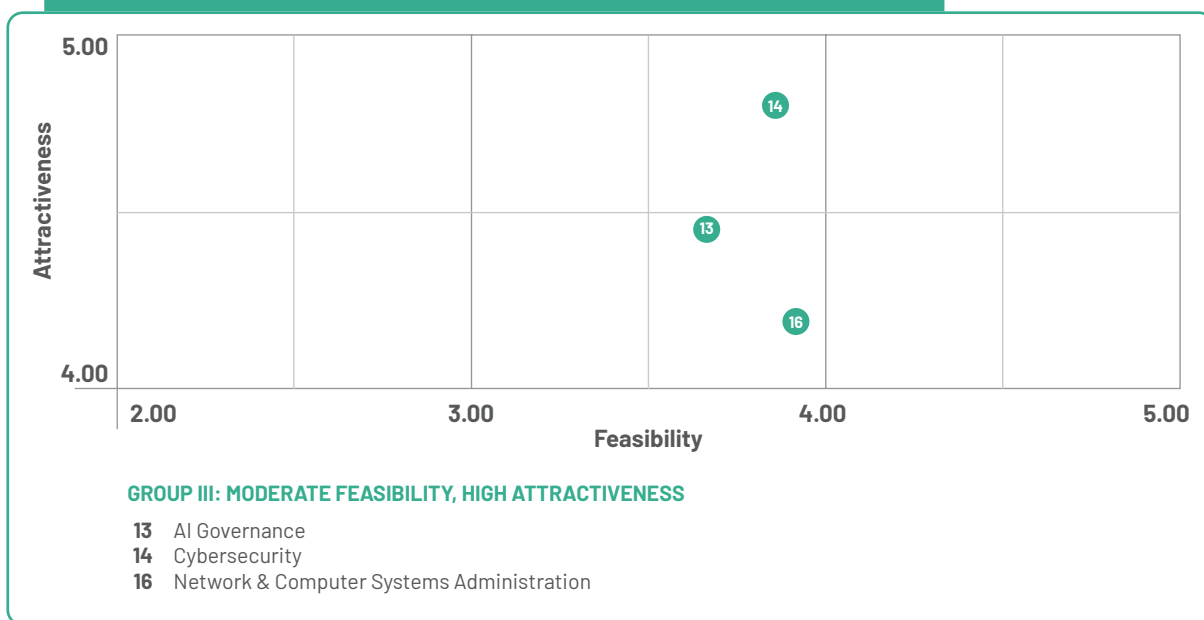


Figure 2.12 Prioritised Digital Security and Cyber Defence skills.

STEM SKILL	PRIORITISATION	ATTRACTIVENESS	FEASIBILITY
AI Governance	Group III (Moderate Feasibility + High Attractiveness)	AI Governance is strongly aligned with the needs of new and emerging industries driving innovation and competitiveness. By promoting ethical and responsible AI use, ensuring compliance with global standards and fostering public trust, this skill directly supports Malaysia's economic growth and positions the nation for a sustainable digital future.	Existing ecosystem only moderately enables the adoption of AI governance skills in the industry, with some standards and frameworks in place but gaps in enforcement, awareness and sector readiness.
Cybersecurity		Demand for this skill in Malaysia is expected to grow, driven by rapid digital transformation, rising cyber threats and the expansion of sectors like finance, healthcare, smart cities and Industry 4.0. As businesses increasingly rely on secure digital systems, cybersecurity will remain a critical enabler for productivity, job creation and national competitiveness.	Existing ecosystem supported by national strategies and regulatory frameworks provides a strong foundation for the adoption of cybersecurity across industries. While the core infrastructure is in place, improvements in talent development, SME involvement and ecosystem coordination are still needed to fully optimise industry-wide integration.
Network and Computer Systems Administration		This skill is essential for supporting interconnected systems, smart manufacturing and emerging technologies, making it a critical enabler of digital transformation. This skill aligns closely with Malaysia's economic growth ambitions by ensuring industries remain competitive and connected in the global digital economy.	Presently, adoption of this skill through higher education institutions that structure curricula based on established industry standards. The rise of AI and collaboration with industry providers further strengthen the ecosystem, ensuring graduates are equipped with relevant, job-ready skills.
Data Governance	Not prioritised	Data governance was not identified as one of the prioritised skills contributing directly to Malaysia's future economic value, possibly because it is often perceived as a compliance or regulatory function rather than a direct driver of innovation and economic impact (IBM, 2025).	

## WHY IT MATTERS FOR MALAYSIA?

Confidence in e-commerce, fintech, e-government and smart city services depends on credible protection of data and operations. As threats rise in frequency and sophistication, strong defence is no longer a specialist concern. It is an economy-wide requirement that sustains investor confidence and citizen uptake.

### Critical infrastructure resilience safeguards national missions

Energy, health, transport and manufacturing rely on connected technologies. Weakness in cyber practice can trigger service disruption, financial loss and reputational damage, delaying programmes that matter for growth and public welfare. Robust governance and operational readiness reduce the likelihood and impact of such events.

### Employment shifts towards defence, assurance and governance roles

Automation will take over routine monitoring, while demand grows for security engineers, incident responders, threat hunters and specialists in AI governance and secure systems administration. Career pathways expand from technician and administrator roles to advanced positions that combine technical depth with policy and risk literacy.

### Economic impact comes from avoided losses and faster adoption

Stronger security lowers downtime, reduces fraud and recovery costs and speeds the safe rollout of digital services. This improves productivity and keeps firms and agencies on schedule for transformation, while supporting export opportunities in trusted digital solutions.

### Potential negative impact

Digital Security and Cyber Defence skills, while essential, present several potential negative impacts across society, culture and the environment.

- In society, risks include privacy infringements from surveillance, job displacement, growing digital inequality, poorly designed AI policies and vulnerabilities from weak or siloed network management that could enable cybercrime or misinformation.
- Culturally, these skills may trigger resistance to new practices, over-reliance on automated systems, suppression of diversity through biased governance and loss of public trust due to frequent cyber incidents or imposed digital norms.
- Environmentally, cybersecurity operations, AI models and large-scale network infrastructures demand high energy and contribute to e-waste through constant hardware upgrades.

These risks highlight the need for ethical, inclusive and sustainable approaches to digital security.

## INCREASING FUTURE PREPAREDNESS

### Knowledge depth needed

Cybersecurity practice benefits from a wide talent base at MQF Levels 6 to 8, ranging from practitioners who implement and operate controls to experts who design architectures, lead response and shape national security posture. AI governance typically requires at least MQF Level 7 given its ethical, legal, technical and societal dimensions. Network and computer systems administration can be mastered at MQF Levels 5 to 6, with Advanced Diplomas preparing technicians and Bachelor's degrees equipping professionals for enterprise-level management. Together, these pathways develop both a broad practitioner pipeline and a specialised cadre for advanced assurance.

### When the STEM Skills will be required

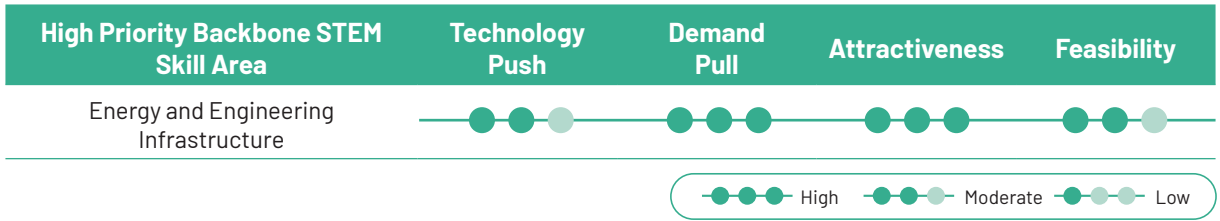
Core capabilities in cybersecurity, network and systems administration and AI governance are needed now onwards. Through the 2030s, depth in zero-trust architectures, secure-by-design engineering, safety assurance for AI systems and sector-specific control frameworks becomes more important. Toward 2040, readiness for post-quantum cryptography, autonomous defence tooling with human oversight and continuous conformity assessment will matter for critical infrastructure and cross-border services.



### Signals to watch

- Mean time to detect and respond for government and critical sectors
- Coverage of baseline controls, including multi-factor authentication, network segmentation and backup integrity tests
- Adoption of zero-trust reference architectures and secure-by-default development practices
- Uptake of AI governance frameworks and documented model-risk assessments in high-impact use cases
- Share of critical infrastructure undergoing periodic independent cyber audits and resilience exercising
- Incidence and cost of material cyber events, including ransomware recovery times
- Growth in certified practitioners across cybersecurity and systems administration and participation by SMEs in assurance programmes

## 2.2.4 ENERGY AND ENGINEERING INFRASTRUCTURE



### WHAT IS IT?

Energy and Engineering Infrastructure refers to the interdisciplinary domain dedicated to the design, construction, operation and maintenance of systems essential for energy production, distribution and broader physical infrastructure. This includes sectors such as renewable energy systems, power generation (electrical and mechanical), civil and structural engineering, process automation, mechatronic integration, marine and offshore systems and reliability engineering where engineering design meets energy efficiency, sustainability and resilience.

### Attractiveness-Feasibility of Energy & Engineering Infrastructure area for future economic value

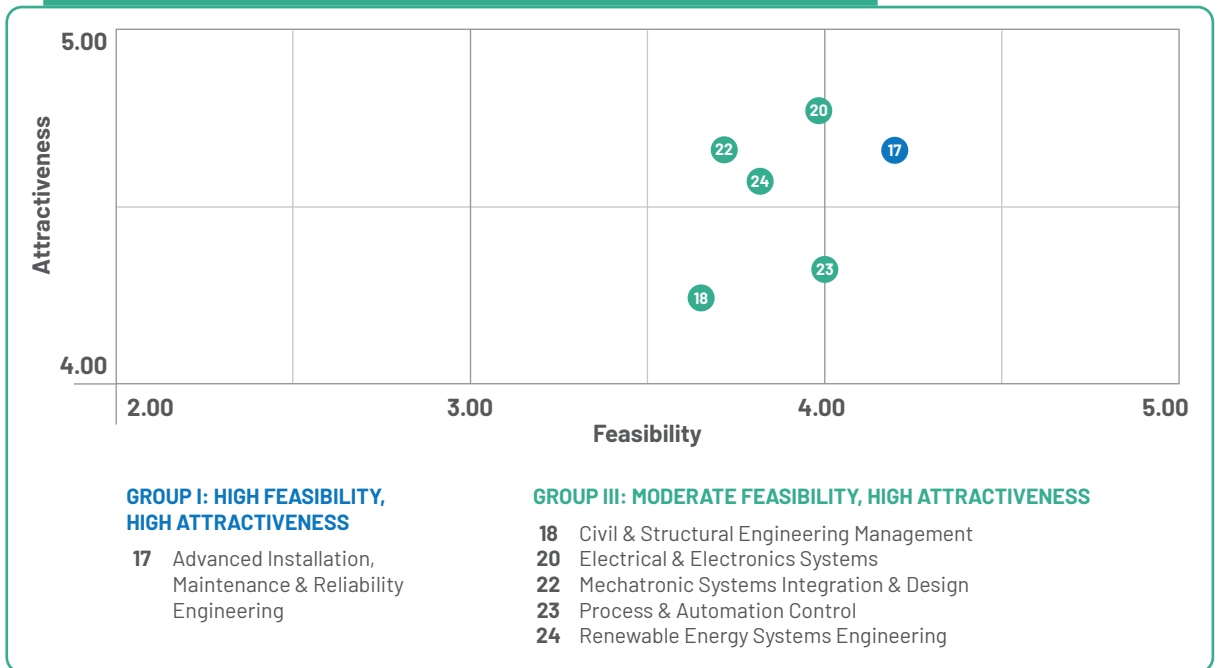


Figure 2.13 Prioritised Energy and Engineering Infrastructure skills.

STEM SKILL	PRIORITISATION	ATTRACTIVENESS	FEASIBILITY
Advanced Installation, Maintenance and Reliability Engineering	Group I (High Feasibility + High Attractiveness)	This skill is essential for ensuring the optimal performance and longevity of complex, high-value systems across strategic sectors such as space, aerospace, defence and energy. As Malaysia advances into AI-driven and digitalised industries, this skill underpins operational reliability, supports technological self-reliance and enhances national competitiveness by attracting high-value investments and enabling industrial resilience.	Existing industrial ecosystem feasibly supports the adoption of this skill, particularly in established sectors like oil & gas, aerospace, energy and manufacturing where international standards and practices are already in place. However, broader adoption is still limited by gaps in local certification, training access and academia-industry collaboration
Civil and Structural Engineering Management	Group III (Moderate Feasibility + High Attractiveness)	This STEM skill supports Malaysia's economic growth by enabling modern, technology-integrated infrastructure, attracting foreign investment and creating high-demand job opportunities for the younger generation.	Existing ecosystem moderately enables adoption of this skill. However, to fully enable industry-wide adoption, further efforts are needed including long-term national policies, upskilling of local talent and greater integration of advanced technologies into education and workforce development systems.
Electrical and Electronics Systems		This skill will be in highly demand over the next years, driven by Malaysia's strategic focus on emerging technologies such as semiconductors, electric vehicles, AI, IoT and renewable energy. As the country positions itself as a global high-tech hub, demand will surge for skilled professionals in design, automation, embedded systems and advanced manufacturing to support national initiatives	Malaysia has a solid foundation for the adoption of Electrical & Electronics Systems, supported by a strong export-oriented E&E sector, skilled talent pipelines, multinational industry presence and government policies. However, gaps remain in advanced R&D, local design and component capabilities and broader adoption particularly among SMEs and rural industries requiring stronger industry-academia collaboration and infrastructure upgrades.
Mechatronic Systems Integration and Design		The demand for this skill in the coming years is expected to grow rapidly as Malaysia advances towards Industry 4.0 and high-growth sectors. This skill will be critical to fill new roles such as robotics technicians, automation engineers and IoT system integrators, making them highly sought after for driving innovation, productivity and economic growth.	Existing ecosystem provides a basic foundation for adopting this STEM skill, but gaps in skill alignment, SME readiness and practical training still limit its effectiveness.

STEM SKILL	PRIORITISATION	ATTRACTIVENESS	FEASIBILITY
Process and Automation Control	Group III (Moderate Feasibility + High Attractiveness)	This skill demand is anticipated to increase in coming years as industries accelerate adoption of Industry 4.0, digitalisation, robotics and smart manufacturing technologies. This growth will drive the need for highly skilled professionals in system design, integration, programming and maintenance, creating new, higher-value roles across Malaysia's industrial sectors.	Existing ecosystem partially supports the adoption this skill. A wider integration requires greater investment in talent development, access to advanced technologies and stronger collaboration between academia, industry and technology providers to meet evolving digital transformation needs.
Renewable Energy Systems Engineering		This skill is critically aligned with Malaysia's transition toward a low-carbon economy and its commitment to net-zero emissions by 2050. This skill support emerging industries such as solar, hydrogen and energy storage.	Malaysia has a growing ecosystem for Renewable Energy Systems with supportive academic institutions, industry-academia collaboration and well-developed infrastructure for solar energy; however, broader adoption across industries remains limited due to challenges in manpower, integration, compatibility and investment.
Data Engineering	Not prioritised	Data engineering was not identified as one of the prioritised skills contributing directly to Malaysia's future economic value, possibly because it is often regarded as a supporting or enabling function rather than a high-impact driver on its own (Data Science Institute, 2025). While it does not deliver immediate, visible outcomes like AI modelling or data analytics, data engineering plays a critical role in building and maintaining the infrastructure that makes these applications possible. Its contribution is therefore indirect but essential, ensuring that data pipelines, integration systems and storage frameworks are reliable and efficient to support the success of higher-priority AI and data-related skills.	
Marine and Offshore Engineering		Marine and Offshore Engineering skill was not prioritised likely because Malaysia's long-term economic strategy is shifting towards renewable energy, sustainability and digitalisation, while traditional offshore oil and gas activities, which this skill is most strongly associated with are expected to gradually decline in economic significance (Syaheezam, Zamzuri, Sirajasharifudeen, Mohd Noor Sirajajudeen, & Abdul Rani, 2025).	
Digital and Control Systems Engineering		Digital and Control Systems Engineering skill, while highly valuable as an enabling technology, may not have been prioritised because its role is often considered indirect supporting other high-priority domains such as process automation, smart systems, or advanced manufacturing, rather than serving as a standalone driver of economic value. The skill is already embedded in Malaysia's industrial base, which may have led to it being viewed as a baseline competency rather than a future differentiator (Economic Planning Unit, 2023)	

## WHY IT MATTERS FOR MALAYSIA?

The Energy and Engineering Infrastructure area is central to Malaysia's long-term industrialisation, energy transition and economic growth. As the country implements the National Energy Transition Roadmap (NETR) and pursues large-scale infrastructure projects, this area becomes both a driver of economic resilience and a major source of employment transformation. Reliable, low-carbon infrastructure underpins growth and investment as grid stability, modern transport and water systems and efficient industrial plants are pre-conditions for high-value activities. Strong engineering capability reduces downtime and safety incidents, supports electrification and attracts investment in advanced manufacturing and services.

### The energy transition creates new roles and reshapes existing work

As renewables, storage and smart grids scale, demand grows for engineers in renewable systems, power electronics, mechatronics, process control and civil and structural management. Routine and manual tasks in construction and traditional operations decline as automation and digital oversight spread, increasing the premium on multidisciplinary problem solving and safety leadership.

### Productivity and resilience improve through integration and control

Modern control and automation raise throughput and quality, while reliability engineering extends asset life and lowers lifecycle costs. These capabilities shorten project schedules, reduce exposure to supply disruptions and deliver measurable gains in energy and resource efficiency across plants and utilities.

### Strategic implications for competitiveness and the energy transition

Progress in this area accelerates delivery of national missions by aligning skills to grid modernisation, renewable build-out, industrial electrification and safe construction of major works. It also strengthens export readiness in electrical and electronic systems and in engineering services that support regional infrastructure projects.

### Potential negative impact

The Energy and Engineering Infrastructure area, while vital for national progress, presents several potential negative impacts if not managed responsibly.

- Societally, automation and digitalisation may displace low-skilled workers, widen socio-economic disparities and introduce safety risks, while poor governance or cybersecurity vulnerabilities could undermine public trust.
- Culturally, heavy reliance on high-tech systems risks eroding traditional knowledge, diminishing local identity and creating workplace resistance or dehumanised, efficiency-driven environments.
- Environmentally, the sector's high energy demands, reliance on resource-intensive materials and large-scale infrastructure projects can lead to increased carbon emissions, e-waste, habitat loss and long-term ecological harm if hazardous materials are not properly managed.

These risks highlight the need for reskilling, ethical governance, cultural sensitivity and sustainable practices alongside technological advancement.

## INCREASING FUTURE PREPAREDNESS

### Knowledge depth needed

The Energy and Engineering Infrastructure area is academically intensive, with most skills requiring at least a Bachelor's degree (MQF Level 6) as the core level of mastery. Advanced roles in renewable energy, civil megaprojects, smart grids and automation innovation demand postgraduate training (Levels 7 to 8). Technician-level contributions are possible at MQF Level 5 (Advanced Diploma), but higher education is the main driver of mastery. This highlights the need for Malaysia to strengthen engineering education pipelines from diploma to doctoral levels, ensuring a workforce capable of supporting both immediate infrastructure development and long-term energy transition.

### When the STEM Skills will be required

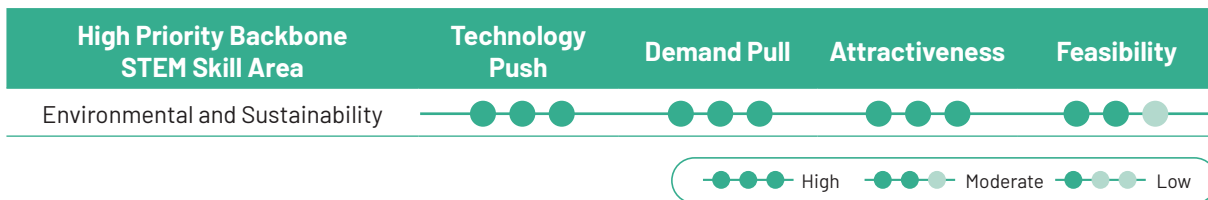
Core capabilities in reliability, electrical and electronic systems, mechatronic integration and process and automation control are needed now and should scale across plants and infrastructure programmes. Civil and structural management remains in sustained demand through the 2030s as major works proceed. Renewable energy systems engineering grows from current momentum to mass-market deployment through the 2030s, with deeper integration of storage and smart grid functions expanding toward 2040.



### Signals to watch

- Grid reliability indicators and connection lead times for new loads and generators
- Installed renewable capacity, storage deployments and share of variable generation managed through advanced control
- Overall equipment effectiveness and unplanned downtime in priority industrial plants
- Number of certified practitioners in reliability, process control, mechatronics and renewable systems
- Adoption of digital project delivery and safety performance in civil and structural works
- Uptake of industry-academia placements and apprenticeships aligned to energy transition projects

## 2.2.5 ENVIRONMENTAL AND SUSTAINABILITY



### WHAT IS IT?

Environmental and sustainability brings together the science, tools and governance needed to preserve ecological balance, cut pollution and waste and steward resources over the long term. It refers to the interdisciplinary domain focused on designing, implementing and managing systems, technologies and processes that preserve ecological balance, reduce environmental harm and support long-term resource stewardship.

#### Attractiveness-Feasibility of Environmental & Sustainability area for future economic value

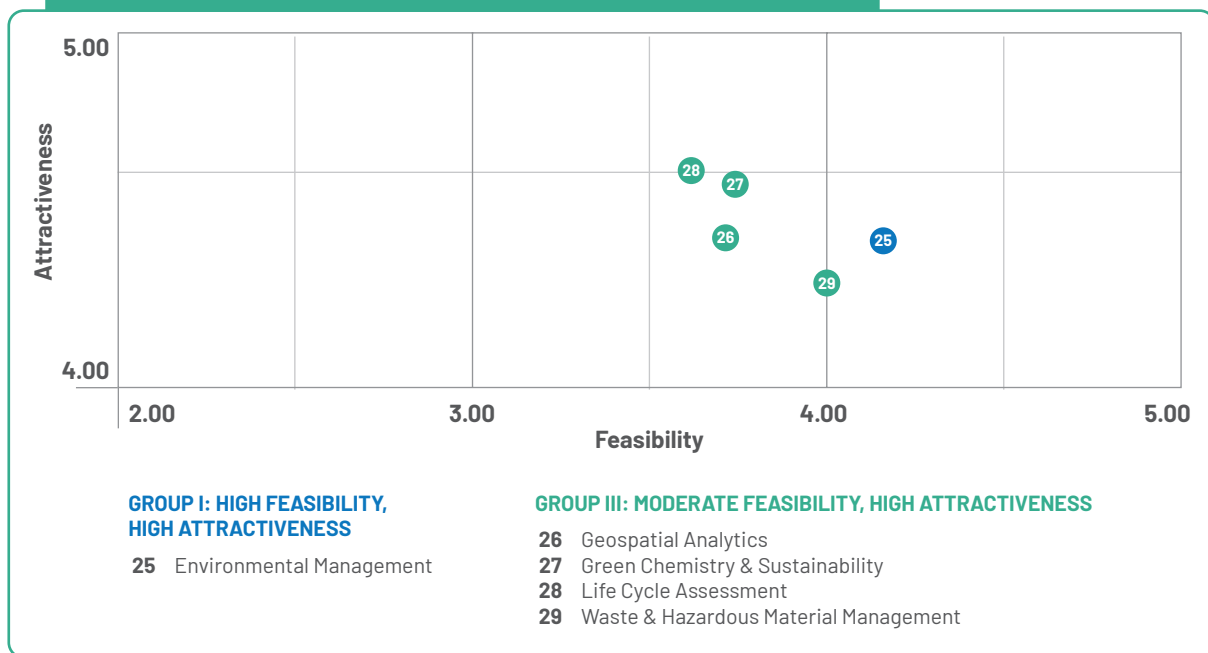


Figure 2.14 Prioritised Environmental and Sustainability skills.

STEM SKILL	PRIORITISATION	ATTRACTIVENESS	FEASIBILITY
Environmental Management	Group I (High Feasibility + High Attractiveness)	This STEM skill is aligned with emerging industries such as green technology, renewable energy, sustainable agriculture and the circular economy. It enhances Malaysia's economic growth by supporting regulatory compliance, enabling ESG adoption and attracting green investments.	While many sectors, particularly export-driven and global-facing ones, have integrated environmental practices, broader implementation across SMEs and less regulated industries still requires greater incentives, awareness and structural support to ensure full nationwide adoption.
Geospatial Analytics	Group III (Moderate Feasibility + High Attractiveness)	Demand for this STEM skill is anticipated to rise driven by its wide applicability across industries. As more companies seek geospatial expertise and integrate it with AI and big data, the need for skilled professionals will continue to grow.	This STEM skill is supported by government, industry and educational institutions in Malaysia, indicating a positive foundation for adoption into the existing industry landscape. However, it is not yet widely trained and more targeted training efforts are needed to fully integrate the skill across sectors.
Green Chemistry and Sustainability		This STEM skill is essential for driving innovation in eco-friendly products, waste reduction and efficient resource use, aligning with global ESG demands and Malaysia's goals for a circular economy and carbon neutrality.	Current ecosystem is only partially ready to adopt Green Chemistry and Sustainability, with academic support and research in place but limited industrial application due to outdated technologies and weak enforcement of environmental regulations.
Life Cycle Assessment		The demand for this STEM skill in the next 10 to 15 years will grow significantly as global supply chains, ESG reporting requirements and international environmental commitments drive industries toward greener practices.	The existing ecosystem in Malaysia provides limited support for this STEM skill adoption, as it remains largely voluntary, complex and resource-intensive, with minimal regulatory push or mandatory requirements.
Waste and Hazardous Material Management		By integrating advanced technologies such as waste-to-energy systems and managing emerging waste streams like Electrical Vehicle (EV) batteries and solar panels, this STEM skill can drive Malaysia's circular economy and contribute significantly to future economic growth.	Existing ecosystem moderately supports this STEM skill, backed by regulatory frameworks as well as growing industry awareness of environmental responsibilities.

## WHY IT MATTERS FOR MALAYSIA?

The Environmental and Sustainability skill cluster is critical to Malaysia's long-term socio-economic development, as it directly supports the country's commitments to climate resilience, low-carbon growth and the Net Zero 2050 target. Strengthening this area enables Malaysia to address pressing environmental challenges such as deforestation, biodiversity loss, waste mismanagement and the high carbon intensity of energy and industrial activities.

Sustainability capability also protects market access and advances national commitments. It supports compliance with supply-chain requirements and green finance standards, reducing the risk of trade barriers on exports and helping firms participate in higher-value segments.

### **New green industries and circular models create jobs and reduce long-term costs**

Capability in environmental management, cleaner production and resource recovery opens opportunities in renewable energy, circular economy services, green materials and eco-innovation. At the same time, better stewardship lowers the future costs of environmental degradation, disaster response and health impacts.

### **Employment shifts toward analytics, engineering and assurance**

Demand grows for environmental managers, geospatial analysts, life cycle practitioners, green process and product engineers and specialists in waste and hazardous material management. Routine, compliance-only roles give way to data-driven practice that integrates measurement with redesign and verification across supply chains.

Scaling these skills strengthens Malaysia's credentials with investors and global customers, while improving planning for land, water and energy. Integration with digital and AI tools increases transparency and speeds learning cycles, helping agencies and firms prioritise high-impact interventions.

### **Potential negative impact**

The Environmental and Sustainability skill cluster, while vital for Malaysia's green transition, also carries potential negative impacts if not managed responsibly.

- Societally, these include job displacement from automation, widening inequality due to limited access to advanced training, economic burdens on SMEs and low-income groups and risks such as greenwashing, data misuse, or weak governance that could undermine public trust.
- Culturally, overreliance on Western-centric or tech-driven solutions may erode traditional knowledge, marginalise local values and create resistance to change, while some transitions such as waste management may carry social stigma or dehumanise workplaces.
- Environmentally, unintended impacts may arise from high energy use, e-waste generation, resource-intensive green technologies, or poorly designed tools and projects that disrupt ecosystems, highlighting the need for inclusive, transparent and holistic sustainability practices.

## INCREASING FUTURE PREPAREDNESS

### Knowledge depth needed

The Environmental and Sustainability skill cluster requires a minimum mastery level of MQF Level 6 (Bachelor's Degree), which provides comprehensive theoretical and applied competence across key domains. Postgraduate qualifications (MQF Levels 7 to 8) are increasingly important for advanced roles in leadership, innovation and policy-making, while technician-level support roles can be effectively developed through MQF Levels 4 to 5 (Diploma/Advanced Diploma). This underscores the importance of strengthening bachelor-level education pipelines to ensure broad workforce readiness, while simultaneously expanding postgraduate pathways to cultivate high-level expertise in sustainability science, innovation and governance.

### When the STEM Skills will be required

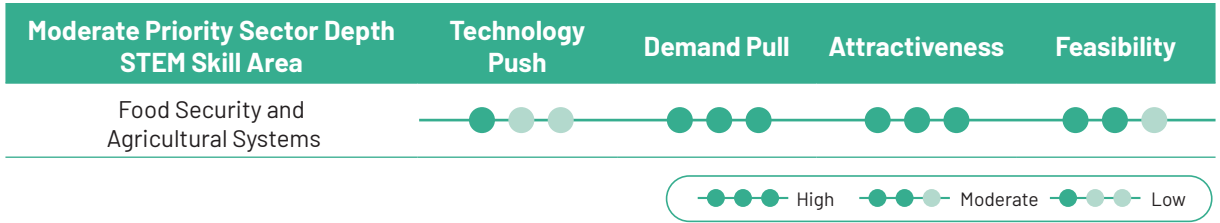
Core capabilities in Environmental Management and Geospatial Analytics are needed now onwards, with mass-market uptake expected as reporting and land-use decisions become more data-rich. Green Chemistry and Sustainability and Life Cycle Assessment scale through the late 2020s and 2030s as cleaner production and product stewardship become standard in manufacturing and construction. Waste and Hazardous Material Management is critical now, with demand rising further through the 2030s as new waste streams emerge from electrification and renewable deployment.



### Signals to watch

- Share of firms with certified environmental management systems and public ESG disclosures
- Adoption of life cycle assessment in procurement and product design and the number of qualified LCA practitioners
- Use of geospatial datasets and analytics in permitting, enforcement, disaster risk management and land-use planning
- Volume of waste diverted from landfill, hazardous waste treated to standard and recovery rates for critical materials
- Energy and water intensity trends in priority sectors and uptake of cleaner production methods
- Flows of green investment and the share of projects meeting international sustainability taxonomies

## 2.2.6 FOOD SECURITY AND AGRICULTURAL SYSTEMS



### WHAT IS IT?

Food Security and Agricultural Systems bring science, engineering and data together across the farm-to-fork chain to secure reliable, safe and sustainable food. It refers to the interdisciplinary domain focused on ensuring the availability, accessibility, safety and sustainability of food through science, technology and innovation across the entire agricultural value chain. It integrates agricultural management, precision farming, food engineering and processing, sustainable farming practices and One Health approaches to enhance productivity, safeguard public and animal health and build resilience against climate change and global disruptions.

#### Attractiveness-Feasibility of Food Security & Agriculture Systems area for future economic value

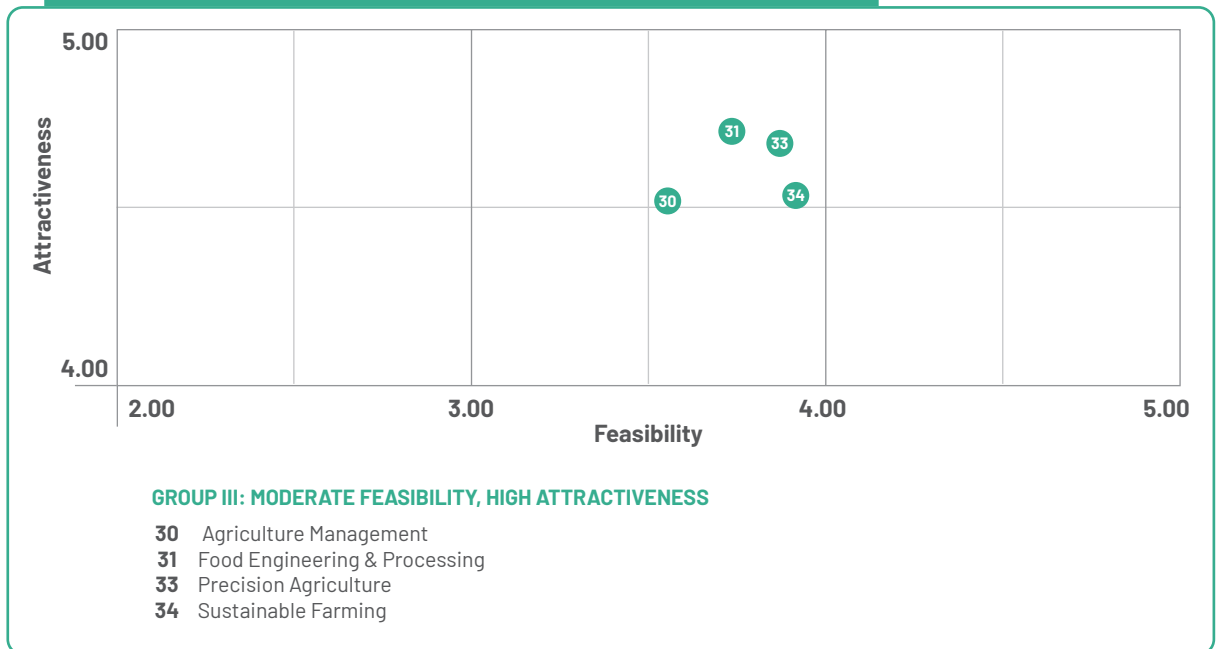


Figure 2.15 Prioritised Food Security and Agriculture Systems skills.

STEM SKILL	PRIORITISATION	ATTRACTIVENESS	FEASIBILITY
Agriculture Management	Group III (Moderate Feasibility + High Attractiveness)	This skill in the next 10 to 15 years is expected to rise significantly as Malaysia prioritises food security, modernises its agriculture sector and adopts smart farming technologies aligned with IR 4.0.	Existing ecosystem provides a strong foundation for adopting this STEM skill, with comprehensive structures and growing support for technology and innovation. However, challenges such as high execution costs, academic-focused learning, talent mismatches.
Food Engineering and Processing		The demand for Food Engineering and Processing skills in Malaysia is expected to remain very high over the next 10 to 15 years, driven by the country's push to modernise its agri-food sector, strengthen halal food production and meet rising global demand for healthy and high-quality food.	Existing ecosystem supports the adoption of this STEM skill through established food safety standards, regulatory frameworks and alignment with Industry 4.0 initiatives. While adoption is feasible, gaps remain in technology uptake among SMEs and the consistent application of best practices across the industry.
Precision Agriculture		Malaysia modernising its agricultural sector, with rising needs for expertise in AI, IoT, drone operations, data analytics and autonomous farming systems will boost productivity, reduce input costs, enhance food security and position Malaysia as a regional hub for smart farming innovation and foreign investment.	Malaysia already has an enabling ecosystem for Precision Agriculture through existing agricultural institutions, pilot testbeds, innovation grants and smart farming demonstration. However, while adoption into the industry landscape is feasible, further efforts in standardised protocols, rural connectivity and capacity building are needed to fully integrate this STEM skill.
Sustainable Farming		This STEM skill will see strong demand over the next 10 to 15 years as Malaysia faces rising food needs due to population growth and global supply chain disruptions, requiring scientific, tech-driven agriculture to ensure food security.	Existing ecosystem can support the adoption of this STEM skill, as the agriculture sector is receptive to advanced technologies and the foundational systems are in place. However, to fully integrate this STEM skill into the industry landscape and meet international standards, further investment, ecosystem coordination and certification alignment are needed.
One Health and Zoonotic Disease Management	Not prioritised	Despite its importance in public health, is often perceived as a preventive, reactive ecosystem service rather than a direct driver of economic value. While this skill area is crucial to safeguarding human, animal and environmental health, its economic benefits are mostly long-term and indirect. For instance, the Malaysian One Health framework emphasises multidisciplinary coordination across agriculture, veterinary and health sectors, especially for managing zoonoses and antimicrobial resistance (Malaysian One Health Antimicrobial Resistance, 2024).	

## WHY IT MATTERS FOR MALAYSIA?

The Food Security and Agricultural Systems area is fundamental to Malaysia's national resilience, as it ensures the availability, accessibility, safety and sustainability of food supplies for a growing population while reducing dependence on imports. With Malaysia currently importing a significant share of its staple foods, strengthening this area is crucial to safeguard against global supply chain disruptions, climate change impacts and market volatility.

### Technology elevates yields, quality and traceability

Precision Agriculture, Sustainable Farming and Food Engineering and Processing enable targeted inputs, better soil and water stewardship, lower post-harvest loss and higher-value products. Real-time sensing and analytics improve decisions from planting to processing, while modern QA and certification open access to premium and halal markets.

### Employment shifts towards agri-tech, data and sustainable operations

Traditional manual roles shrink as automation and digital tools spread. Demand grows for practitioners who can manage farms as data-rich systems, operate precision equipment and drones, run safe and efficient processing lines and implement sustainability standards across supply chains. This shift lifts skill intensity and supports higher incomes in rural regions.

### Economic impact combines import substitution with value addition

Higher, more consistent yields and better processing raise domestic supply and reduce leakage. At the same time, innovation in product quality, safety and branding increases competitiveness in regional markets, creating opportunities in agri-tech services and food exports.

### Potential negative impact

The Food Security and Agricultural Systems area, while vital for Malaysia's resilience, presents several potential negative impacts across society, culture and the environment.

- Societally, the adoption of automation, precision farming and modern processing technologies may cause job displacement, widen the digital divide and place economic pressure on smallholders and SMEs due to high transition costs and compliance with sustainability standards. Issues such as data privacy risks, greenwashing and unequal access could also undermine trust and deepen inequality.
- Culturally, the emphasis on standardised, technology-driven solutions risks eroding traditional farming knowledge, food heritage and indigenous practices, while rapid changes may face resistance from rural communities or create stigma around waste-related and low-status agricultural work.
- Environmentally, unintended harms may arise from overuse of chemicals and inputs, resource-intensive food systems, large-scale land-use change, e-waste from agri-tech and high energy consumption.

These risks highlight the need for inclusive policies, capacity building for smallholders, culturally sensitive approaches and sustainable practices to ensure food security innovation strengthens Malaysia's resilience without creating new vulnerabilities.

## INCREASING FUTURE PREPAREDNESS

### Knowledge depth needed

Across the Food Security and Agricultural Systems area, MQF Level 6 (Bachelor's Degree) is consistently identified as the minimum mastery level to ensure professionals possess sufficient technical and theoretical knowledge. Diploma-level training (MQF levels 4 to 5) plays a crucial role in producing skilled technicians for operational and support functions, while postgraduate levels (MQF levels 7 to 8) are essential for leadership, specialised research and policy innovation. This highlights the need for Malaysia to strengthen bachelor-level agricultural and food science programs while ensuring inclusive pathways through TVET and postgraduate specialisations to build a resilient food security workforce.

### When the STEM Skills will be required

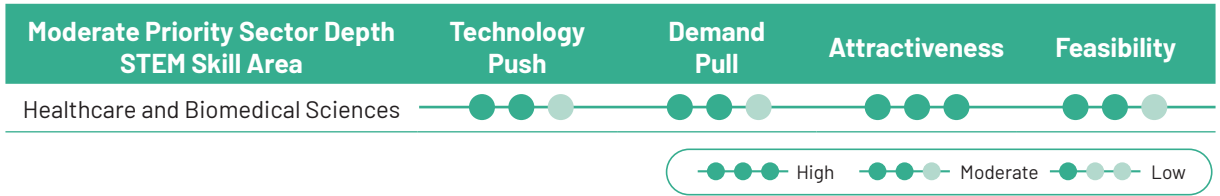
Core demand is now onwards for Agriculture Management and Food Engineering and Processing as the sector modernises and scales compliance. Precision Agriculture and Sustainable Farming expand from current pilots to mass-market adoption through the 2030s, supported by rural connectivity, shared services and certification. Toward 2040, deeper integration of autonomous systems, climate-resilient practices and circular bioeconomy models becomes mainstream.



### Signals to watch

- Domestic production share for priority commodities and trends in import reliance
- Yield gains and input efficiency from precision methods and reductions in post-harvest loss
- Uptake of farm connectivity, remote sensing and decision-support tools among smallholders and SMEs
- Share of processing facilities certified to recognised food safety and halal standards and compliance outcomes
- Adoption of sustainability certifications and verified regenerative practices across supply chains
- Growth in agri-tech services, equipment usage and industry-academia pilot sites supporting scale-up

## 2.2.7 HEALTHCARE AND BIOMEDICAL SCIENCES



### WHAT IS IT?

Healthcare and Biomedical Sciences span the continuum of healthcare technology from biomedical product development and engineering to clinical practice, diagnostics and imaging, good laboratory practice, multi-omics analysis, patient-centred care, pharmaceutical sciences and synthetic biology. It is foundational to modern biomedical innovation, precision medicine and Malaysia's healthcare transformation goals.

#### Attractiveness–Feasibility of Healthcare and Biomedical Sciences area for future economic value



Figure 2.16 Prioritised Healthcare and Biomedical Sciences skills.

STEM SKILL	PRIORITISATION	ATTRACTIVENESS	FEASIBILITY
Biomedical Product Development and Engineering	Group III (Moderate Feasibility + High Attractiveness)	This STEM skill is strongly aligned with Malaysia's ambition to grow into a high-tech, innovation-driven economy, as they enable advancements in medical devices, digital health and precision medicine boosting healthcare resilience, global competitiveness and economic growth.	Existing ecosystem provides a moderate foundation for adopting this STEM skill, supported by relevant government agencies, research institutes and policies, alongside some R&D funding. However, gaps in regulatory readiness, clinical validation pathways, technology transfer and industry-academia collaboration
Clinical and Medical Practice		Over the next 10 to 15 years, the demand for Clinical & Medical Practice skills in Malaysia is expected to rise significantly due to an aging population, persistent healthcare workforce shortages and the increasing integration of AI and digital health technologies.	Existing ecosystem does support the adoption of this STEM skills across industries such as biotechnology, medical devices and digital health. However, challenges such as uneven access to training, limited rural resources, funding constraints, regulatory gaps and brain drain indicate that further investment, streamlined governance and stronger industry-academia collaboration are needed to fully realise its potential.
Good Laboratory Practice Management		The demand for this STEM skill is expected to grow significantly over the next 10 to 15 years as Malaysia advances in automation, biotechnology, renewable energy and high-value manufacturing, requiring strict adherence to international standards and quality systems.	Existing ecosystem does support the adoption of this STEM skills, with several accredited GLP laboratories, available resources such as instructors and notes and industry awareness and capacity to integrate these practices.
Multi-omics Integrated Analysis		This STEM skill is aligned with the needs of new and emerging industries in Malaysia, as it supports precision medicine, precision agriculture, sustainable forestry and biopharmaceutical manufacturing while driving innovation in health, biotechnology and environmental sciences.	Current ecosystem in Malaysia does not yet fully enable the adoption of this STEM skill into the existing industry landscape, as there is a lack of widespread infrastructure, technology platforms and sufficient funding and resources.
Pharmaceutical Sciences		This STEM skill is strongly aligned with the needs of new and emerging industries that can enhance Malaysia's economic growth, particularly in areas like drug discovery, biotechnology and personalised medicine, which remain underexplored locally.	Current ecosystem only partially supports the adoption of pharmaceutical science skills, as the industry still focuses largely on traditional manufacturing with limited advanced R&D capacity.

STEM SKILL	PRIORITISATION	ATTRACTIVENESS	FEASIBILITY
Synthetic Biology		In the next 10 to 15 years, the demand for this STEM skill in Malaysia is expected to grow significantly, driven by high-value industries such as biomanufacturing, green pharmaceuticals, sustainable agriculture and biotechnology.	The existing ecosystem in Malaysia does not yet fully enable the adoption of this STEM skill into the industry landscape, as it remains in its infancy with limited R&D capacity, expertise and high-tech facilities.
Diagnostic and Imaging Expertise	Not prioritised	Essential for effective clinical care, but its role is largely confirmatory rather than transformational in economic terms. It represents a baseline healthcare capability already well-established in Malaysia, offering indirect economic contributions that support patient care rather than drive broader industrial or innovation growth. The sector also faces challenges such as potential overutilisation, which can lead to inefficiencies and marginal value despite high cost and complexity (iResearchNet, n.d.).	
Patient-Centered Services		Enhance care quality and patient satisfaction but are primarily viewed as part of service delivery standards rather than direct economic growth drivers. These offerings tend to deliver domestic healthcare value such as patient trust and reduced hospital stays without significantly impacting Malaysia's position in global health innovation or export markets.	

## WHY IT MATTERS FOR MALAYSIA?

### A driver of high-skill jobs and a growth engine in global health value chains

The Healthcare and Biomedical Sciences area is a vital contributor to Malaysia's future economic value chain because it generates high-value employment and drives growth in knowledge-intensive industries. It creates diverse professional pathways in clinical care, biomedical engineering, pharmaceutical science, biotechnology and supporting services such as clinical trials and digital health. It raises skill intensity and supports the shift toward an innovation-driven economy while strengthening participation in export-oriented medical device and biopharma markets.

### Stronger health security and national resilience

Local capability in vaccines, diagnostics and therapeutics reduces reliance on imports and shortens response times in crises. Multi-omics analysis and high-quality laboratory practice support precision medicine and public health surveillance, improving preparedness and outcomes.

### Employment shifts towards translational and regulated practice

Demand grows for biomedical product engineers, clinical practitioners with digital and AI fluency, laboratory managers with Good Laboratory Practice, bioinformaticians for multi-omics integration and pharmaceutical scientists who can move candidates through regulated pipelines. Routine tasks give way to roles that combine science, regulation and data.

### Economic impact through higher value services, exports and investment

Capabilities in regulated product development and quality systems attract investment, enable regional service exports and open collaboration with international partners. Over time, this raises self-sufficiency, improves trade balances for selected products and builds reputational capital for Malaysia as a trusted health innovation hub.

### Potential negative impact

The Healthcare and Biomedical Sciences area, while critical for advancing Malaysia's healthcare system and innovation capacity, also carries notable potential negative impacts.

- Societally, the rapid adoption of advanced medical technologies, pharmaceuticals and biomedical engineering may lead to job displacement, rising healthcare inequalities between urban and rural communities and privacy risks from genetic, clinical, or patient data misuse. Overreliance on technology could also undermine clinical judgment, while high transition costs may burden smaller institutions and widen socio-economic gaps.
- Culturally, standardised clinical protocols, pharmaceutical dominance and synthetic biology interventions risk eroding traditional and indigenous health practices, creating ethical and religious tensions and marginalising non-STEM knowledge systems. These changes may also reduce patient trust if not implemented with sensitivity to local values.
- Environmentally, the sector generates significant risks through medical and biomedical waste, hazardous chemical use, energy-intensive hospital and lab operations and risks from synthetic biology or biotech applications, which could disrupt biodiversity and ecosystems if poorly managed.

Overall, while this area is indispensable for Malaysia's healthcare resilience and competitiveness, it requires careful governance, inclusive policies and sustainable practices to ensure that progress does not exacerbate inequality, cultural erosion, or environmental harm.

## INCREASING FUTURE PREPAREDNESS

### Knowledge depth needed

The Healthcare and Biomedical Sciences skill cluster requires advanced academic preparation, with mastery generally situated at the postgraduate level (MQF 7–8). Fields such as Clinical and Medical Practice, Pharmaceutical Sciences, Multi-omics Integrated Analysis and Synthetic Biology demand Master's or Doctoral qualifications to enable complex diagnostics, research innovation, precision medicine and leadership in health technology development. At the same time, Bachelor's degrees (MQF 6) provide the essential foundation for core competencies across areas such as Good Laboratory Practice Management, biomedical product development and entry-level clinical roles. Diploma and Advanced Diploma levels (MQF 4–5) remain important for producing technologists and support staff who perform operational and technical functions. This tiered structure highlights the need for Malaysia to strengthen its bachelor-to-postgraduate education pipeline, ensuring a broad base of competent practitioners while cultivating a specialised cadre of researchers, innovators and healthcare leaders to drive biomedical and healthcare advancement.

### When the STEM Skills will be required

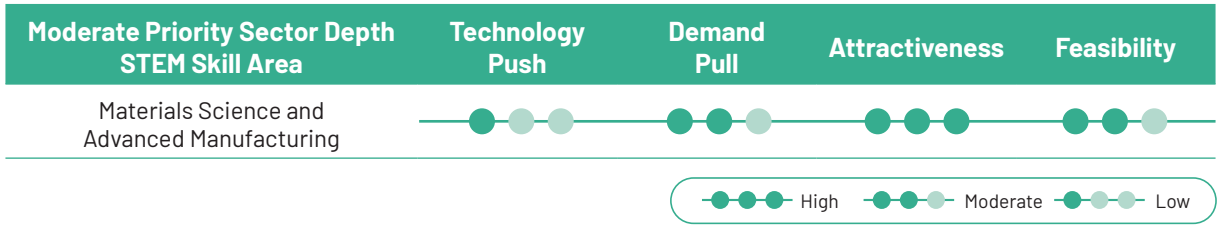
Capabilities with immediate and sustained demand include Biomedical Product Development and Engineering, Clinical and Medical Practice, Good Laboratory Practice Management and Pharmaceutical Sciences. Multi-omics Integrated Analysis scales from early adoption to broader use through the 2030s as platforms, data and talent deepen. Synthetic Biology remains a longer-horizon play, with focused pilots and partnerships now and wider biomanufacturing applications toward 2040 as infrastructure, standards and specialist skills mature.



### Signals to watch

- Number of regulated products progressing from prototype to clinical validation and market authorisation
- Accredited GLP or equivalent laboratories and compliance performance in audits
- Adoption of multi-omics workflows in clinical and public health settings, including qualified practitioners
- Domestic manufacturing capacity for priority medicines, vaccines and diagnostics and associated investment flows
- Growth in clinical trials activity, contract research and manufacturing and international partnerships
- Postgraduate completions and specialist certifications in the prioritised skills and retention in Malaysian institutions and firms

## 2.2.8 MATERIALS SCIENCE AND ADVANCED MANUFACTURING



### WHAT IS IT?

Materials Science and Advanced Manufacturing bring foundational research in materials together with applied engineering strategies from Advanced Materials Engineering (developing next-generation composites, smart materials) to Surface & Packaging Engineering (enhancing durability and sustainability) and Material Science itself (understanding material behaviour for innovation). It underpins national goals in high-value manufacturing, green technology and industrial competitiveness.

#### Attractiveness–Feasibility of Material Science & Advanced Manufacturing area for future economic value

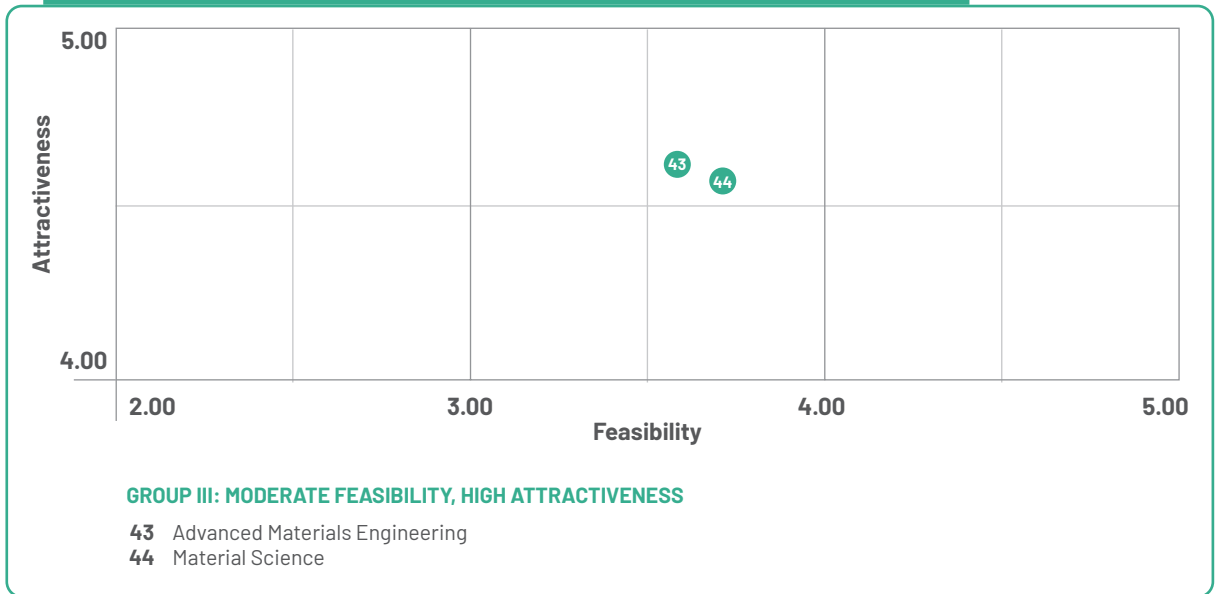


Figure 2.17 Prioritised Material Science & Advanced Manufacturing skills.

STEM SKILL	PRIORITISATION	ATTRACTIVENESS	FEASIBILITY
Advanced Materials Engineering	Group III (Moderate Feasibility + High Attractiveness)	This skill is aligned with the needs of new and emerging industries crucial to Malaysia's economic growth, including aerospace, electronics, renewable energy, automotive and biomedical sectors. By enabling product innovation, improving efficiency and lowering construction and production costs, this skill supports Malaysia's transition to high-tech, high-value industries.	Malaysia's ecosystem provides a foundational support for the adoption of this STEM skill through STEM education policies, R&D initiatives and government-industry collaborations; however, the system remains largely theoretical with limited hands-on, industry-aligned training.
Material Science		This STEM skill is aligned with the needs of Malaysia's emerging industries such as renewable energy, electric vehicles, semiconductors and downstream rubber production. This STEM skill supports innovation, workforce readiness and foreign investment attraction, making it a critical driver of national economic growth and technological advancement.	Current ecosystem provides a foundation for adopting this skill through policies, industrial PhD programmes and public-private research initiatives. However, limited cross-disciplinary collaboration, insufficient industry-academia integration.
Surface and Packaging Engineering	Not prioritised	Though important for product durability, safety and sustainability, was not prioritised because it is seen as a supporting function with incremental contributions rather than a transformative driver of economic growth. In Malaysia, the packaging industry is heavily shaped by global suppliers and imported technologies, limiting its potential as a major differentiator compared to high-impact areas such as AI, renewable energy and advanced materials (Malaysian Investment Development Authority, 2021).	

## WHY IT MATTERS FOR MALAYSIA?

The Materials Science and Advanced Manufacturing area is a cornerstone of Malaysia's industrial transformation, with direct implications for both employment and economic growth. As Malaysia advances toward Industry 4.0 and strengthens its position in the global E&E, automotive, aerospace and medical device industries, new materials and advanced production methods will drive higher productivity, innovation and global competitiveness.

### Materials capability moves firms up the value chain

Competitiveness in electrical and electronic products, medical devices, automotive components and aerospace depends on how well materials are specified, processed and qualified. Strong capability in material selection, process integration and reliability lifts first-pass yield, expands product families and opens higher-margin market segments.

### Employment shifts toward process, characterisation and digital manufacturing

Demand grows for materials and process engineers, characterisation and failure-analysis specialists, reliability engineers, additive manufacturing and advanced joining technicians and production leaders skilled in quality systems and data-rich process control. Routine manual roles decline as plants adopt automation, sensors and model-based optimisation.

### **Economic impact comes from higher productivity, export readiness and greener production**

Advanced materials and smarter processes reduce scrap and energy use, shorten qualification cycles and support compliance with international standards. This strengthens Malaysia's position in regional supply chains and attracts investment in higher-value manufacturing, while circular design and cleaner production lower long-term costs and environmental liabilities.

### **Strategic implications for national priorities**

Progress in this area underpins mission goals in semiconductors, energy technologies, mobility electrification and healthtech. Prioritised skills in advanced materials engineering and materials science provide the foundation for product innovation, while selected packaging and surface treatments act as enabling functions as ecosystems mature. Aligning shared labs, standards and industry placements to these needs accelerates diffusion from research to line-ready practice.

### **Potential negative impact**

The Materials Science and Advanced Manufacturing area, while central to Malaysia's industrial growth and competitiveness, presents several potential negative impacts across society, culture and the environment.

- Societally, rapid innovation in advanced materials may create urban inequities if high-tech materials are concentrated in exclusive infrastructure, while also risking workforce displacement as automation and advanced manufacturing reduce reliance on low-skilled labour. There are also risks of skill obsolescence and health hazards from improper handling of nanomaterials or hazardous compounds.
- Culturally, the preference for high-tech materials could displace traditional, local, or culturally significant materials and practices, eroding heritage in construction, crafts and design, while engineered materials that do not align with local values may face community resistance.
- Environmentally, advanced material production is often resource- and energy-intensive, contributing to resource depletion, toxic waste, e-waste and pollution. Moreover, unregulated use of nanomaterials could cause ecological imbalances with unknown long-term consequences.

These risks highlight the need for sustainable sourcing, circular design principles, inclusive access and culturally sensitive approaches, ensuring that material innovations strengthen Malaysia's resilience without undermining equity, culture, or the environment.

## INCREASING FUTURE PREPAREDNESS

### Knowledge depth needed

Mastery of Materials Science and Advanced Manufacturing skills requires at least a Bachelor's degree (MQF 6), with postgraduate levels (MQF 7 to 8) necessary for advanced innovation, leadership and research roles. Technician-level roles can be supported through MQF 3 to 5, ensuring a layered workforce pipeline. This shows Malaysia must build both a broad base of bachelor-level graduates to meet immediate industry needs and a specialised cadre of postgraduates to drive high-value materials research and innovation.

### When the STEM Skills will be required

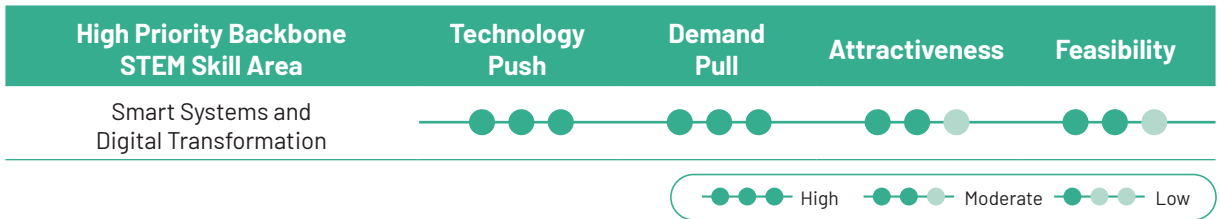
Core materials and process skills are needed now onwards across electronics, medical devices and engineered products. From 2028 to 2035, depth in advanced composites, battery and power-electronics materials, microfabrication and advanced joining and reliability-centred design becomes more important as firms target higher-value niches. Toward 2040, circular materials, bio-based polymers, nanostructured coatings and fully digital thread manufacturing scale as standards, test methods and supply chains mature.



### Signals to watch

- First-pass yield, scrap rates and energy intensity trends in priority manufacturing lines
- Number of certified labs and practitioners in materials characterisation, reliability and failure analysis
- Adoption of advanced processes such as additive manufacturing, advanced joining and high-precision packaging in export-oriented plants
- Time from prototype to qualified production for new materials or processes and associated conformance to international standards
- Growth in industry-academia projects and shared facility utilisation for pilot lines and scale-up
- Patents, publications and licensing deals in advanced materials and manufacturing methods that originate from Malaysian institutions and firms

## 2.2.9 SMART SYSTEMS AND DIGITAL TRANSFORMATION



### WHAT IS IT?

Smart Systems and Digital Transformation encompass the integrated development of intelligent, adaptive and connected digital solutions that transform systems, processes and user experiences across sectors in Malaysia from industry to public services and everyday life. It combines technologies such as embedded systems, IoT, software engineering, system architecture and user experience design to enable systems that sense, analyse, respond and learn. This is the integration layer that links Artificial Intelligence and Data Technologies to the physical world so that operations become more reliable, responsive and safe.

Attractiveness–Feasibility of Smart Systems & Digital Transformation area for future economic value

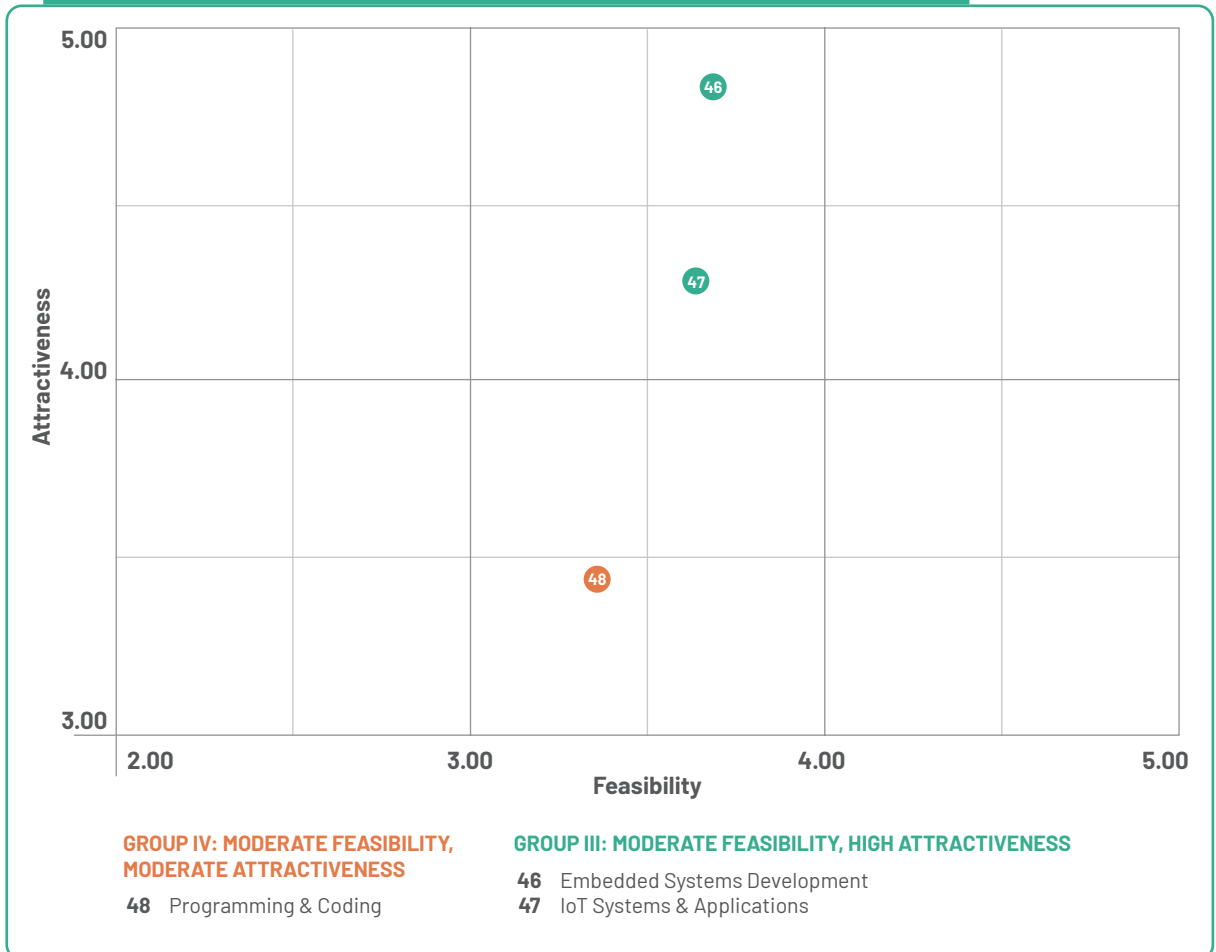


Figure 2.18 Prioritised Smart Systems and Digital Transformation skills.

STEM SKILL	PRIORITISATION	ATTRACTIVENESS	FEASIBILITY
Embedded Systems Development	Group III (Moderate Feasibility + High Attractiveness)	This skill is closely aligned with the needs of emerging industries, supporting advancements in AI, IoT, automation and smart technologies for manufacturing, transportation and infrastructure. This skill drives innovation in electronic engineering, enabling Malaysia to meet local and global demands while enhancing economic growth.	The existing ecosystem in Malaysia provides some foundational talent for Embedded Systems Development, primarily through exposure to open-source tools and university programmes. However, limited awareness, reliance on foreign expertise and insufficient financial support for local entrepreneurs hinder broader adoption and industry integration.
IoT Systems and Applications		The demand this STEM skill in the next 10 to 15 years is expected to be high, driven by global trends and the increasing integration of electronics and automation in industry workflows. This skill will open new opportunities, support productivity gains and require advanced competencies in system design and development, making them vital for economic growth and job creation in Malaysia.	Mastering IoT Systems & Applications in Malaysia is moderately challenging, as it requires both theoretical knowledge and access to practical tools, which are not yet fully integrated into the current education system. Lack alignment with industry standards, highlighting the need for improved training providers and stronger industry-academia collaboration.
Programming and Coding	Group IV (Moderate Feasibility + Moderate Attractiveness)	Programming and Coding is a crucial skill for creating software, applications and automated systems, driving digital industry growth and innovation across sectors. The demand for this skill is expected to remain very high over the next 10 to 15 years as global economies continue to expand their reliance on digital technologies and automation.	Programming and Coding is supported by Malaysia's existing ecosystem, but gaps remain in talent quality and adoption, particularly among SMEs. While the infrastructure exists, industries often rely on imported talent for specialised or cost-sensitive programming needs, highlighting the need for stronger local capability development.
Software Development and Testing	Not prioritised	These skills are increasingly commoditised, as the rise of low-code and no-code platforms and AI-driven development tools simplifies software creation and reduces reliance on traditional coding expertise. As a result, these skills are viewed as baseline capabilities rather than high-impact economic drivers globally.	
System Architecture and Design		Often perceived as a supportive and enabling function, this skill is essential for digital infrastructure but does not itself drive economic transformation in the same way as high-growth areas like AI, cybersecurity, or robotics. Its impact tends to be embedded within broader digital systems rather than standing alone as a differentiator.	
UX Engineering		Though vital for technology adoption, UX engineering is seen primarily as a service-oriented function focused on domestic usability rather than an export or innovation-driven skill. Its contribution is incremental boosting user experience without creating new industrial or global value chains.	

## WHY IT MATTERS FOR MALAYSIA?

Smart systems lift productivity, quality and service reliability. Real-time monitoring, predictive maintenance and end-to-end traceability raise equipment uptime, reduce waste and energy use and improve customer and citizen experience. Because these capabilities are horizontal rather than niche, they accelerate diffusion of AI and data across sectors and rely on robust digital security to keep integrated operations trusted. It underpins the transition to an innovation-driven, high-income economy.

### High technology push and broad demand make this a near-term accelerator

Economically, smart systems adoption enhances efficiency, cost savings and innovation capacity, attracting foreign direct investment (FDI) in high-tech industries while fostering local startups and SMEs in the digital sector. It also drives inclusive growth by enabling e-commerce, digital finance and smart city initiatives that connect rural and urban communities to new opportunities.

A balanced view is important. Rapid automation can displace routine work if reskilling lags. Poorly segmented networks increase cyber exposure. Interoperability gaps and vendor lock-in add cost and slow scaling. Fast device turnover can also increase e-waste and energy use. These risks argue for open standards, lifecycle security, inclusive access for SMEs and regions and responsible design that respects language and local contexts.

### Roles shift from manual oversight to integration and digital operations

From an employment perspective, digital transformation is reshaping the labour market. Traditional clerical, routine and low-skilled jobs are increasingly automated, while demand is rising for data analysts, system architects, cybersecurity experts, software developers and digital product designers. This shift creates an urgent need for reskilling and upskilling programmes to prepare Malaysia's workforce for Industry 4.0 and beyond. The result is a move away from labour-intensive employment toward higher-value, knowledge-based digital jobs, aligning with Malaysia's long-term human capital development goals.

### Potential negative impact

The Smart Systems and Digital Transformation area, while crucial for Malaysia's digital economy, presents several potential negative impacts across society, culture and the environment.

- Societally, widespread adoption of IoT, embedded systems and coding may lead to job displacement through automation, digital inequality as SMEs and low-income groups struggle with costs and cybersecurity risks such as hacking, surveillance and misuse of data. Poorly designed or malicious software could also drive social manipulation or misinformation.
- Culturally, over-standardised or imported digital solutions risk eroding local customs, languages and practices, while automation and smart technologies could reduce human interaction and disrupt traditional lifestyles. Platforms or apps misaligned with local values may further contribute to cultural homogenisation or resistance to adoption.
- Environmentally, the rapid growth of IoT and digital systems contributes to e-waste accumulation, resource extraction and high energy consumption, while inefficient coding or product obsolescence can worsen sustainability challenges.

These risks highlight the importance of embedding ethical design, inclusive access, cultural sensitivity and green digital practices into Malaysia's smart systems and digital transformation agenda, ensuring technological progress does not compromise social trust, cultural diversity, or environmental sustainability

## INCREASING FUTURE PREPAREDNESS

### Knowledge depth needed

Mastery of Smart Systems and Digital Transformation skills generally requires at least a Bachelor's degree (MQF 6), making it the common baseline across IoT, Embedded Systems and Programming and Coding. Diploma-level pathways (MQF 3 to5) play a crucial role in building a pipeline of technicians and junior developers, while postgraduate levels (MQF 7 to8) are essential for advanced R&D, system integration and innovation. This reflects the need for Malaysia to strengthen its bachelor-level digital education, while ensuring inclusivity through TVET for foundational roles and postgraduate specialisation for leadership in smart systems innovation.

### When the STEM Skills will be required

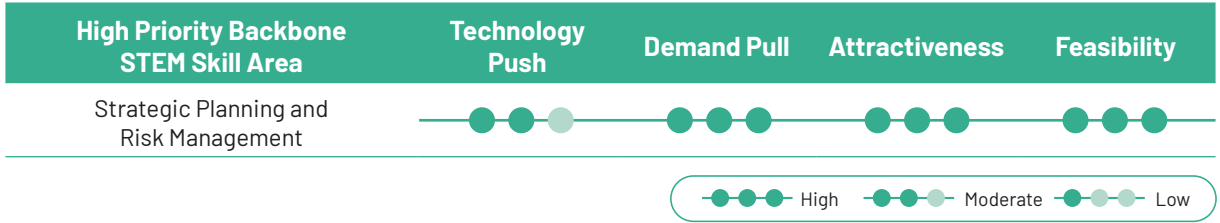
Core capabilities in embedded systems, IoT and programming are needed now and should scale quickly, including for SMEs. Through the 2030s, depth in systems architecture, digital twins and edge orchestration becomes more important. Toward 2040, closed-loop optimisation and higher autonomy mature as standards, security and workforce readiness catch up.



### Signals to watch

- Share of plants and facilities instrumented with IoT and integrated IT-OT dashboards
- Number of digital twin deployments and measured gains in overall equipment effectiveness and energy use
- Uptake of interoperability profiles and secure-by-design certifications for smart systems
- Growth in local systems integration firms and certified embedded or IoT professionals
- Reduction in unplanned downtime and maintenance costs across pilot and scaled sites

## 2.2.10 STRATEGIC PLANNING AND RISK MANAGEMENT



### WHAT IS IT?

Strategic Planning and Risk Management brings together foresight, governance, safety and operational assurance to guide technology adoption and institutional resilience. It covers applied R&D management, disaster preparedness, strategic technology planning, workplace safety and health and related practices that anticipate disruption, protect people and assets and align investment with public value. These capabilities translate intent into executable roadmaps, link innovation to measurable outcomes and keep critical services reliable even as systems become more digital and interdependent.

#### Attractiveness–Feasibility of Strategic Planning And Risk Management area for future economic value



Figure 2.19 Prioritised Smart Systems & Digital Transformation skills.

STEM SKILL	PRIORITISATION	ATTRACTIVENESS	FEASIBILITY
Workplace Safety and Health Management	Group I (High Feasibility + High Attractiveness)	This STEM skill is becoming increasingly critical across high-risk sectors such as advanced manufacturing, construction, logistics, energy and healthcare, driving productivity, reducing risks and enhancing Malaysia's appeal to global investors. Demand for this STEM skill is expected to remain very high as industries adopt automation, AI and complex systems, creating new roles like safety analysts and health technologists.	Malaysia's existing ecosystem with its laws, training programmes and supporting agencies, does enable the adoption of Workplace Safety & Health Management across industries, making it a required STEM skill in most sectors.
Emergency and Disaster Preparedness	Group I (High Feasibility + Moderate Attractiveness)	The STEM skill is strongly aligned with the needs of emerging industries in Malaysia, supporting climate adaptation, risk management and business continuity in critical sectors such as energy, healthcare, transportation, agriculture and smart city development.	Malaysia's ecosystem for Emergency & Disaster Preparedness skill is supported by national agencies, universities and industry-specific regulations, providing a foundation for adoption across sectors. However, the lack of mandatory requirements, such as incorporating disaster risk management into ESG reporting, may limit industry-wide implementation and incentives for proactive preparedness.
Applied R&D Management	Group III (Moderate Feasibility + High Attractiveness)	The STEM skill plays a critical role in translating scientific research into practical, market-ready innovations that address real industry needs, particularly in sectors like advanced manufacturing, biotechnology, green technology, fintech and the digital economy	Mastering Applied R&D Management through existing education and training programs in Malaysia is moderately easy, as most offerings are not fully tailored to the applied, industry-driven aspects of R&D.
Strategic Technology Planning		The STEM skill is highly aligned with the needs of new and emerging industries in Malaysia as it equips organisations with foresight to adopt and scale technologies that drive innovation, competitiveness and sustainable growth.	The current ecosystem in Malaysia generally enables the adoption of Strategic Technology Planning, supported by national planning frameworks, ESG reporting requirements and public service transformation agendas.
Energy Trading & Hedging Strategies	Not prioritised	While vital for energy companies to stabilise cash flows and manage market volatility, this skill primarily supports risk mitigation rather than generating widespread economic value. Its economic contributions are confined to niche financial operations, making it less impactful compared to transformative sectors like renewable energy, AI, or advanced manufacturing.	

STEM SKILL	PRIORITISATION	ATTRACTIVENESS	FEASIBILITY
Quality, Health, Safety & Environment (QHSE) Compliance	Not prioritised	QHSE compliance ensures operational safety and ESG alignment, which are essential for trust and regulatory adherence. However, it is generally viewed as a baseline standard rather than a driver of innovation or export competitiveness. In Malaysia, well-established frameworks like DOSH already underpin this practice, rendering it enabling rather than economically catalytic.	
Technology Risk Management		As a critical protective function, technology risk management safeguards systems against disruptions such as cyber threats and operational failures. While necessary for stability and investor confidence, it does not directly promote the creation of new industries or export opportunities unlike more forward-facing fields like AI or biotech (Security Commission Malaysia, 2024).	

## WHY IT MATTERS FOR MALAYSIA?

Malaysia's transition to an innovation-driven economy depends on dependable services, credible standards and the capacity to manage shocks. Strategic Planning and Risk Management underpins investor confidence, reduces losses from incidents and keeps national missions on schedule by strengthening preparedness across energy, manufacturing, transport, healthcare and digital services.

### Employment shifts towards high-skill roles at the science-policy-operations interface

Demand rises for technology risk managers, safety engineers, compliance and assurance specialists, foresight analysts and disaster management professionals. Career pathways expand from operational roles into positions that blend technical depth with policy literacy and cross-sector coordination, creating knowledge-intensive jobs that lift professional standards across institutions.

### Economic impact comes from avoided disruption and better long-term choices

Applied R&D management aligns research with market needs, strategic technology planning improves capital allocation and workplace safety and health reduce downtime and liability. Strong practice lowers the frequency and severity of incidents, accelerates certification and compliance and improves Malaysia's participation in global value chains that require transparent risk and quality systems.

### Strategic implications for national competitiveness

Embedding these capabilities ensures that adoption of AI, electrification, smart systems and green technologies is safe, ethical and efficient. It enables faster learning cycles through drills, audits and independent review and supports whole-of-government coordination during crises. In combination, this acts as both a shock absorber and a growth enabler for Malaysia's economy.

### Potential negative impact

The Strategic Planning and Risk Management area, while essential for Malaysia's innovation and resilience, carries several potential negative impacts if not managed inclusively and sustainably.

- Societally, Applied R&D Management and Strategic Technology Planning may widen inequalities if benefits are concentrated among wealthy corporations, urban areas, or well-resourced groups, leaving rural and marginalised communities behind. Rapid innovation and automation also risk job displacement, while oversupply of trained professionals in safety or R&D roles could create workforce misalignment. Poor communication in disaster preparedness may trigger public mistrust, anxiety, or overdependence on centralised systems.
- Culturally, prioritising high-tech or standardised approaches risks eroding traditional knowledge systems, indigenous practices and local wisdom, while stringent safety protocols or disaster relocation plans could generate resistance, stigma, or disrupt community ties to heritage and land.
- Environmentally, these skills may inadvertently contribute to resource depletion, waste generation and ecological disruption, whether through unsustainable R&D lifecycles, disposal of safety equipment, rapid emergency infrastructure, or technology-driven e-waste.

Strategic Planning and Risk Management area is indispensable for guiding Malaysia's technological and societal transformation, its deployment must be anchored in equity, cultural sensitivity and environmental responsibility.

## INCREASING FUTURE PREPAREDNESS

### Knowledge depth needed

The knowledge levels required to master skills in the Strategic Planning and Risk Management area highlight the importance of advanced qualifications to support Malaysia's resilience and innovation ecosystem. Master's-level expertise (MQF 7) is essential for leadership roles in Applied R&D Management, Emergency and Disaster Preparedness and Strategic Technology Planning, where strategic foresight, interdisciplinary coordination and policy alignment are critical. Bachelor's-level qualifications (MQF 6) provide the baseline for Workplace Safety and Health Management and serve as the entry point for operational roles across all areas. Together, a tiered pathway from Bachelor's to Master's ensures Malaysia can build both a broad base of competent practitioners and a specialised cadre of leaders capable of driving innovation, safeguarding risks and strengthening long-term national competitiveness.

### When the STEM Skills will be required

Core capabilities in workplace safety and health, applied R&D management, emergency and disaster preparedness and strategic technology planning are needed now onwards. Depth grows through the 2030s as zero-failure expectations rise in critical infrastructure, as climate risks intensify and as AI-enabled systems require new assurance methods. Toward 2040, continuous conformity assessment, post-quantum readiness and cross-border resilience arrangements become standard for internationally connected services and supply chains.



### Signals to watch

- Coverage and quality of organisational risk frameworks, including frequency of drills and independent reviews
- Time to detect, respond and recover for priority hazards in energy, health, transport and digital services
- Share of public and private projects using applied R&D management with clear pathways from prototype to adoption
- Adoption of strategic technology roadmaps linked to budgets and measurable outcomes in ministries and firms
- Workplace safety and health performance, including incident rates and certification across high-risk sectors
- Uptake of sector standards for AI assurance, cyber resilience and critical infrastructure protection, including participation by SMEs

## 2.3 ESSENTIAL SKILLS TO COMPLETE MALAYSIA'S FUTURE STEM TALENT

In addition to the STEM Skills, 10 essential skills were identified to complement these STEM skills critical for shaping well-rounded future STEM talent. Considering the rapid pace of change, blurring of disciplinary boundaries and increasing complexity in today's environment, these essential skills are deemed necessary to ensure STEM talent can adapt, collaborate and thrive in the evolving landscape.

### WHAT IS IT?

Essential skills are the cross-cutting capabilities that allow technical expertise to deliver results in real settings. They enable collaboration, judgement, safe practice and continual learning as technologies evolve. This study identified ten essential skills that apply across every STEM role as shown in Figure 2.20: adaptability and resiliency; collaboration and teamwork; communication; analytical and critical thinking; digital and technology literacy; innovative thinking and problem solving; learning agility; creative and transdisciplinary thinking; ethics and ESG awareness; foresight and futures thinking. Definitions and sources are provided in Appendix E.

ESSENTIAL SKILL	WHAT IT MEANS?
<b>ADAPTABILITY &amp; RESILIENCY</b>	Navigate through the unexpected, respond positively to evolving challenges and recover from setbacks with flexibility and resilience.
<b>ANALYTICAL &amp; CRITICAL THINKING</b>	Ability to analyse, interpret and draw conclusions.
<b>COLLABORATION &amp; TEAMWORK</b>	Managing relationships and working effectively with others to achieve goals.
<b>COMMUNICATION</b>	Convey and exchange thoughts, ideas and information effectively through various mediums and approaches.
<b>CREATIVE &amp; TRANSDISCIPLINARY THINKING</b>	Apply concepts from multiple disciplines by synthesising knowledge and insights to guide decisions, foster cooperation, and drive continuous improvement, while adopting diverse perspectives to connect ideas across fields and generate innovative solutions and improvements.
<b>DIGITAL &amp; TECHNOLOGY LITERACY</b>	Leverage digital technology tools, systems, software and hardware across work processes and activities to solve problems, drive efficiency and facilitate information sharing.
<b>ETHICS &amp; ESG AWARENESS</b>	To practice professional integrity by ensuring innovations align with societal values and organisational policies, while also understanding the principles of sustainable development and the implications of Environmental, Social, and Governance (ESG) factors on the organisation.
<b>FORESIGHT &amp; FUTURES THINKING</b>	Systematic participatory process, involving future intelligence gathering and building visions for the medium to long term future and aimed at informing present-day decisions and mobilising joint actions.
<b>INNOVATIVE THINKING &amp; PROBLEM SOLVING</b>	Identifying complex problems and reviewing related information to develop and evaluate options and implement solutions.
<b>LEARNING AGILITY</b>	Deploy different learning approaches which enable continuous learning across different contexts to drive self-development and the achievement of long-term career goals.

Figure 2.20 Ten essential skill identified to complement prioritised STEM skills.

## WHY IT MATTERS FOR MALAYSIA?

### Essential skills turn technical mastery into outcomes that matter

Malaysia's growth in AI and data, smart systems, energy transitions and health innovation depends on people who can work across disciplines, use evidence well, communicate with users and design ethically. These capabilities shorten adoption cycles, lift productivity and help teams deliver safely and reliably in complex environments.

### Employers need T-shaped talent for mission-driven work

Firms and agencies increasingly organise around problems rather than functions. Therefore, firms are prone to hiring professionals with a blend of deep expertise in one specific area (the vertical bar of the T) and a broad range of general skills and knowledge across other domains (the horizontal bar). A strong technical base combined with essentials such as collaboration, communication and learning agility allows practitioners to move between projects, integrate tools quickly and improve services with users in mind. This blend supports career mobility, strengthens leadership pipelines and reduces the risk of failures linked to weak coordination or poor judgement.

### Essential skills connect directly to priority STEM areas

Digital and technology literacy amplifies the value of Artificial Intelligence and Data Technologies and Smart Systems and Digital Transformation. Ethics and ESG awareness underpin responsible AI, environmental stewardship and product safety. Foresight and futures thinking strengthen Strategic Planning and Risk Management. Creative and transdisciplinary thinking supports Materials Science and Advanced Manufacturing and Healthcare and Biomedical Sciences, where design, regulation and market needs meet. In combination, the essentials make technical capability stick, scale and travel across sectors.

## INCREASING FUTURE PREPAREDNESS

### Knowledge depth needed

Essentials build progressively rather than as a single subject. Schooling and TVET should develop baseline communication, collaboration and digital literacy through practical projects and service learning. Bachelor-level programmes (MQF 6) should integrate analytical and critical thinking, problem solving and teamwork into authentic assessments, industry briefs and capstone projects. Postgraduate pathways (MQF 7 to 8) deepen foresight, ethics and evidence use for leadership in regulation, complex programmes and research translation. Short courses and micro-credentials can document progression at any stage, provided they are tied to demonstrated practice.

### When the essential skills will be required

Demand is now onwards across all sectors. In the near term, collaboration, communication and digital literacy carry the greatest weight for employability and adoption. Through the 2030s, learning agility, innovative problem solving and creative and transdisciplinary thinking become more prominent as work reorganises around integrated systems and data-rich decisions. Toward 2040, foresight and ethics rise in importance as Malaysia steers larger, more automated and interconnected systems with higher public stakes.

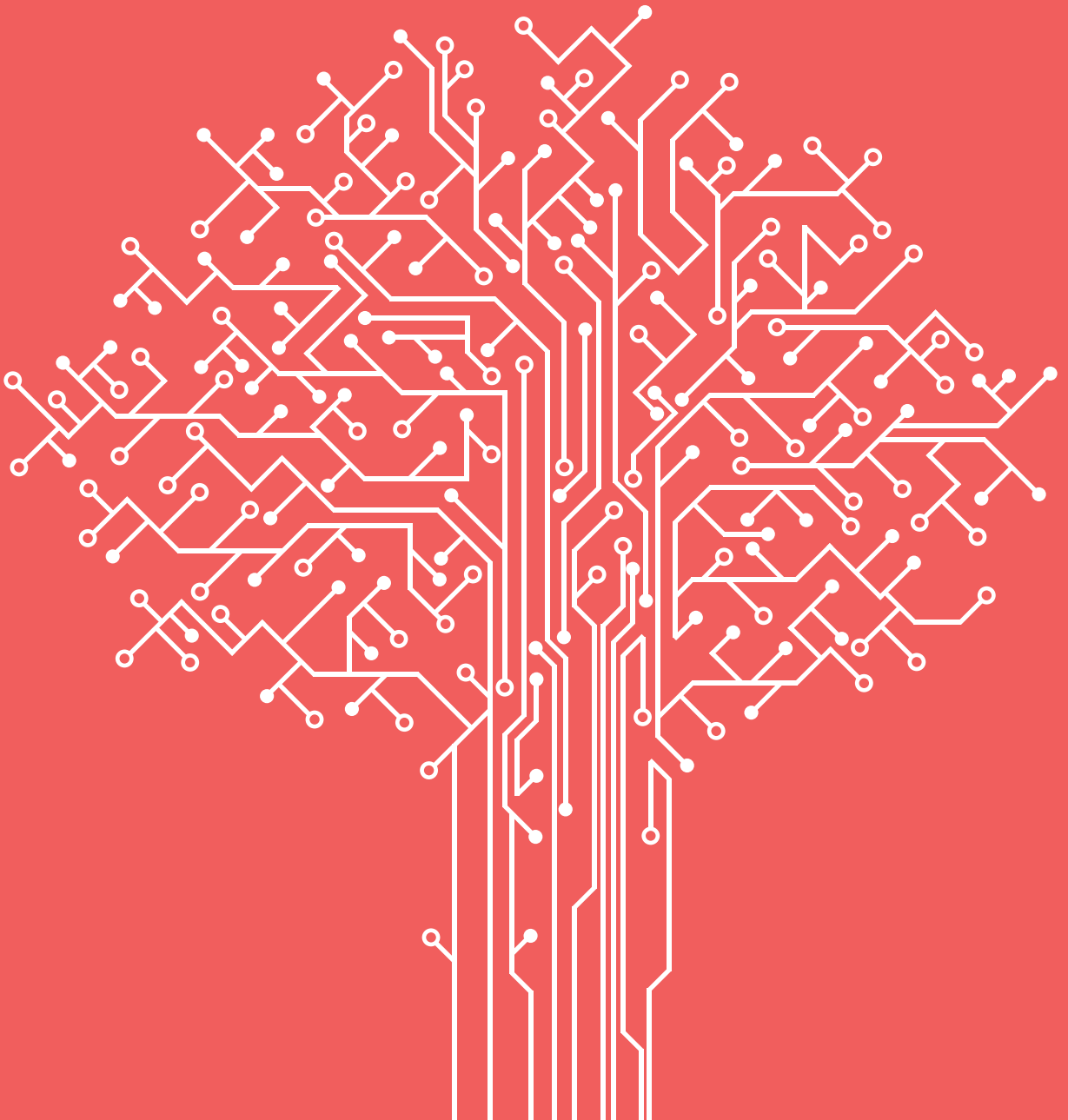


### Signals to watch

- Integration of essential-skills rubrics in degree and TVET assessments, including capstones and work-integrated learning
- Employer use of competency-based hiring and promotion standards that include collaboration, communication and ethics
- Completion of recognised micro-credentials in essentials, with portfolios that evidence real projects and outcomes
- Improvements in team delivery metrics such as project cycle time, quality, safety and user satisfaction
- Uptake of foresight and ESG practices in programme reviews, procurement and product development

## CHAPTER 3

# NAVIGATING MALAYSIA'S FUTURE STEM TALENT CHALLENGES AND OPPORTUNITIES



# NAVIGATING MALAYSIA'S FUTURE STEM TALENT CHALLENGES AND OPPORTUNITIES

Malaysia's innovation ambition depends on how effectively the nation attracts, prepares, deploys, grows and leads its STEM talent. The technologies that matter for competitiveness are advancing quickly and so are the skills that support them. This chapter translates evidence from horizon scanning, foresight, Delphi surveys and stakeholder engagements into practical choices that strengthen Malaysia's talent pipeline and its contribution to national missions in green growth, digital transformation and economic competitiveness.

Malaysia's talent priorities are not evenly spread. They concentrate where fast-moving technologies meet broad industry demand. The study's prioritisation highlights a high-priority backbone of STEM skill areas that cut across sectors, including Artificial Intelligence and Data Technologies, Smart Systems and Digital Transformation, Digital Security and Cyber Defence, Environmental Management and Sustainability, and Strategic Planning and Risk Management. These act as platforms that other activities build on and should anchor the near-term push from insight to implementation.

The ten essential transferable skills underpin the effective application of technical expertise across settings. Collaboration, analytical and critical thinking, digital literacy, innovative problem solving, foresight and ethics enable capability to be deployed, scaled and adapted. These competencies should be integrated as explicit learning outcomes and assessment criteria across the recommendations in this chapter.

The recommendations that follow are advisory. They offer options rather than prescriptions, recognising the different realities faced by ministries, agencies, institutions and firms. Each option is calibrated to a level of ambition as shown in Figure 3.1. From sustaining and sharpening what already works, to extending coverage and raising standards, to taking bold steps where a system shift is warranted. The design is modular so actions can be combined to suit sectoral and regional priorities.



Figure 3.1 Three options of strategic actions based on level of ambition and risk appetite.

**EVIDENCE POINTS TO EARLY EXPOSURE, AI AND SUSTAINABILITY SKILLS, AS WELL AS THE IMPORTANCE OF CONTINUOUS LEARNING AND UPSKILLING.**

Several insights recur across global benchmarks and stakeholder inputs. Early exposure, visible pathways and the engagement of parents and communities convert curiosity into participation. Demand is rising for skills linked to artificial intelligence, data, smart systems and sustainability, yet feasibility gaps persist, which argues for phased enablement through curriculum, teacher capability, applied learning and language readiness. Work integrated learning and mid-career conversion routes are central to closing mismatch in strategic industries. Retention and leadership require structured ladders, research translation and mobility at home and abroad. Governance capacity, anticipatory leadership and ethics are essential for responsible adoption and public trust.

**HOW TO USE THE RECOMMENDATIONS:**

Recommendations are organised around five key strategic themes that mirror the STEM talent journey from attraction to leadership as shown in Figure 3.2.

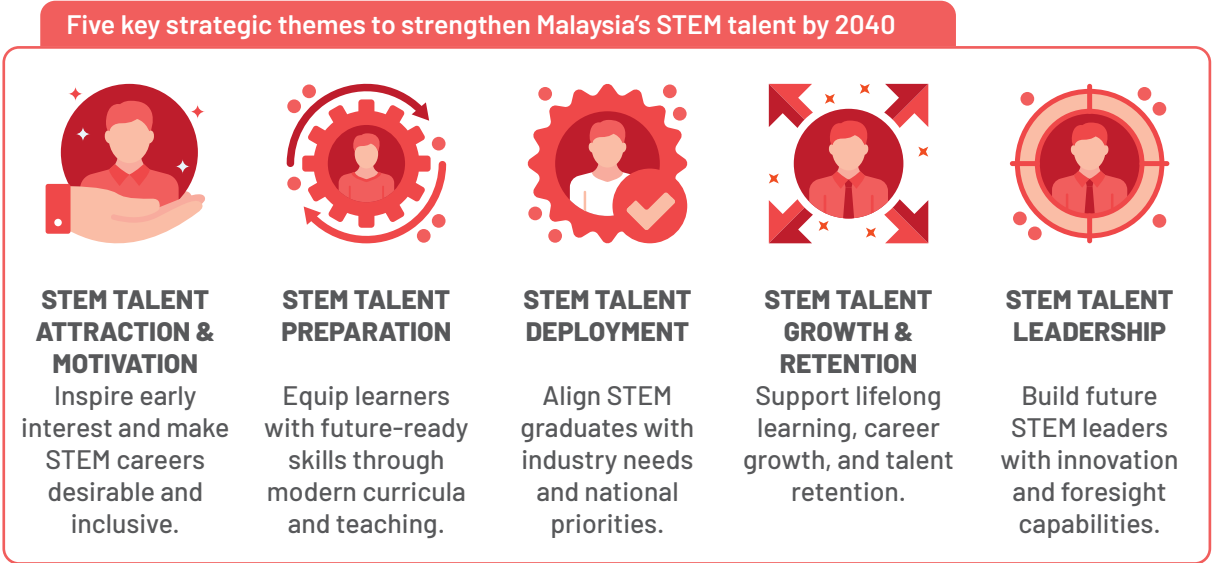


Figure 3.2 Five key strategic themes to strengthen Malaysia's STEM talent by 2040.

Treat the recommendations as a menu of practical choices. Each theme begins with why action is needed, followed by options at three levels of ambition, the MIGHT F.I.R.S.T® Matrix enablers that make delivery possible and a small set of signals to track progress. Select the mix that fits your mandate and context, combine actions across themes and use the signals to learn and scale what works. Combine options across themes to create a coherent package for a sector, a region, or a mission.

The intent of this chapter is to support timely, confident action. By choosing appropriate ambition levels, aligning the necessary enablers and monitoring clear signals, Malaysia can move from insight to implementation, building a resilient STEM talent base that contributes to productivity, inclusion and national competitiveness.

Delivery will depend on coherent enablers. In addition to identifying what needs to be delivered, the chapter also identifies the necessary enablers for successful delivery according to the MIGHT F.I.R.S.T<sup>®</sup> Matrix.

1. Funding and financing supports that unlock scale.
2. The institutions and infrastructure that anchor quality.
3. Regulatory and policy adjustments that remove bureaucratic barriers.
4. Skills and talents needed among educators, managers and mentors.
5. Technologies and innovations that make learning and matching more effective.

Foresight is embedded throughout so that programmes can refresh as conditions change and as new technologies and roles emerge.

### **THE NEED FOR SIGNALS TO MONITOR PROGRESS.**

Progress must be observable. For each theme, leading signals are proposed to show whether early actions are reaching their intended audiences and improving practice, while lagging signals confirm outcomes such as progression, placement and retention. Policymakers can use these signals to test assumptions, adjust course and scale what works.

## 3.1 STEM TALENT ATTRACTION AND MOTIVATION

### CASE FOR ACTION

Malaysia's next decade will be shaped by green transition, digitalisation and health tech. These megatrends are creating new value chains in energy, mobility, advanced manufacturing and services. ICT and e-commerce contribute about 23.5% to Malaysia's GDP in 2023 (MIDA, 2024). While 5G mobile coverage reaches most populated areas and household internet access is high, there are still limited access in rural areas (DOSM, 2025). This creates a strong platform to inspire a broader pipeline. Current and future issues include uneven exposure by geography and income, limited visibility of relatable role models and mixed parental confidence about STEM careers. Opportunities include nationwide digital reach, active community platforms and national missions that make STEM purpose driven. Delphi inputs reinforce early exposure, parental engagement, equity of access and visible pathways as practical near-term moves that convert curiosity into participation.

### WHAT TO EMPHASISE

Where to focus early exposure:

- AI and data in practice via data analytics and visualisation, applied data science and cloud basics, linked to everyday problems students care about.
- Smart systems through simple embedded systems and Internet-of-Things projects that build confidence in sensing, coding and making.
- Digital trust by introducing good cyber hygiene and the idea of AI governance in age-appropriate ways.
- Green orientation through environmental management activities that connect school, community and local industry.
- Essentials threaded through all outreach, especially collaboration, communication and learning agility.

## STRATEGIC OPTION 1.1

### BUILD A NATIONAL STEM IDENTITY AND ASPIRATIONS MOVEMENT

#### Case for action

Attention is fragmented across many initiatives and messages. A single, credible narrative that links STEM to Malaysia's future industries and everyday problems can convert curiosity into sustained interest. Digital reach and community platforms allow national stories and role models to be visible in every district.

#### What are others doing



Science Centre Singapore public engagement programmes



UK STEM Ambassadors for role-model mobilisation



Australia National Science Week for mass outreach

#### CONTINUATION STRATEGIES

- Sustain STEM fairs, competitions, and school outreach.

#### INCREMENTAL STRATEGIES

- Run a unified national STEM narrative tied to future Malaysian industries.
- Feature relatable role models and alumni champions.
- Expand rural outreach circuits and university-school mentoring.
- Offer short STEM starter tasters for non-traditional learners.

#### BOLD & RADICAL STRATEGIES

- Establish permanent STEM Experience Hubs with pop-culture partnerships.
- Set up youth advocacy councils that co-produce campaigns and events.
- Channel top student projects into productisation accelerators.

## STRATEGIC OPTION 1.2

### REPOSITION STEM CAREERS AS PATHWAYS TO SOCIETAL IMPACT

#### Case for action

Youth motivation is purpose driven particularly among the new generation whom are purpose-driven. Framing STEM around climate resilience, food security, health, safety and national productivity connects values to real work. Mission framing also helps employers signal demand in priority sectors identified in national strategies.

#### What are others doing



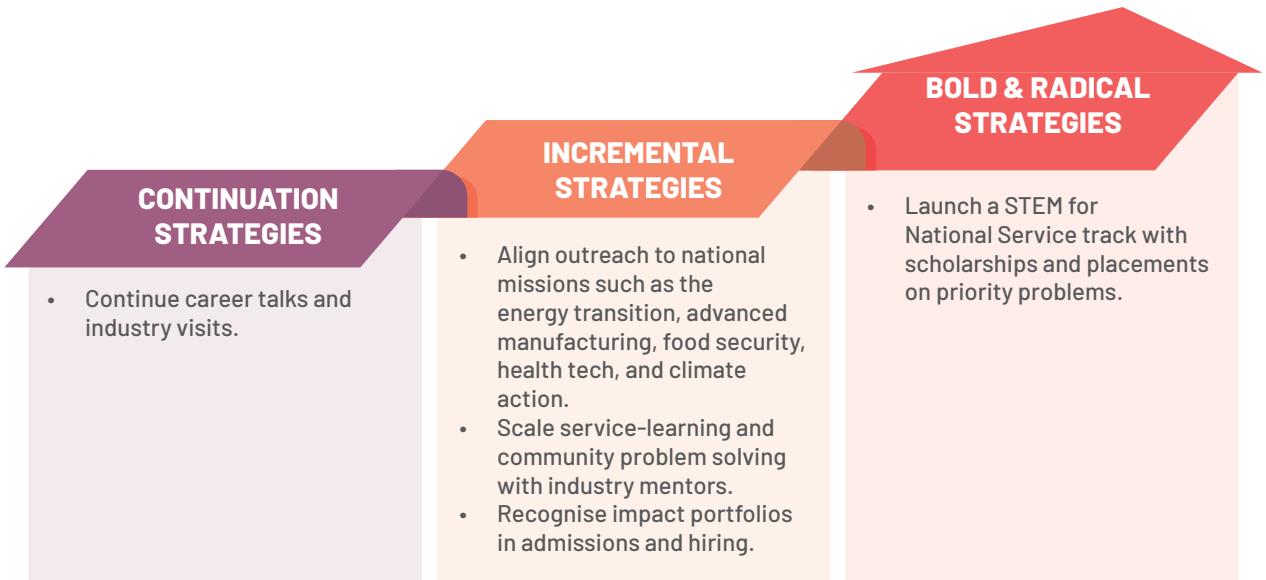
United States service-learning embedded in STEM degrees



For Inspiration and Recognition of Science and Technology (FIRST) Robotics community impact model



Singapore Youth Action Challenge mission briefs



### STRATEGIC OPTION 1.3

#### ENGAGE PARENTS AND COMMUNITIES AS CHAMPIONS OF STEM

##### Case for action

Parents and trusted community leaders shape subject choices and career intent. Clear outcomes, simple pathway maps and visible local success stories address misconceptions and strengthen confidence. Community engagement ensures outreach reaches underserved learners.

##### What are others doing



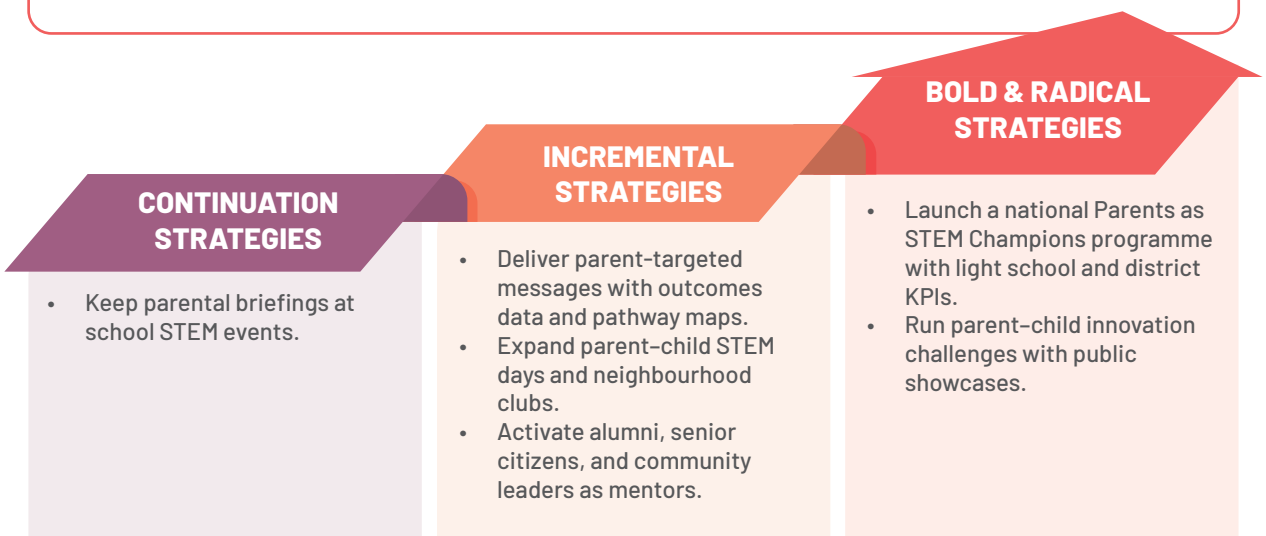
Singapore Parent Support Groups integrated with schools



UK STEM Learning resources for parent engagement



United States PTA STEM family nights



## STRATEGIC OPTION 1.4

### EMBED EARLY STEM ORIENTATION ACROSS EDUCATION PATHWAYS

#### Case for action

Confidence in STEM is built through repeated, hands-on exposure. Introducing discovery modules in AI, sustainability, robotics and health tech from upper primary normalises making and problem solving. Early orientation reduces drop-off at transition points.

#### What are others doing



Korea national STEAM in basic education

Finland phenomenon-based learning

Singapore Applied Learning Programme

#### CONTINUATION STRATEGIES

- Maintain hands-on activities in primary and lower secondary.

#### INCREMENTAL STRATEGIES

- Add upper-primary discovery modules in AI, robotics, sustainability, and health tech.
- Recognise co-curricular STEM in PAJSK.
- Support inquiry-based teaching with ready-to-use kits and micro-CPD.

#### BOLD & RADICAL STRATEGIES

- Make a national STEM orientation module compulsory by Year 5.
- Link orientation to local industry projects and public showcases.

## STRATEGIC OPTION 1.5

### UNLOCK EQUITABLE STEM OPPORTUNITIES FOR UNDERSERVED GROUPS

#### Case for action

Talent is broad but access is uneven. Targeted mentoring, hybrid delivery and material support close exposure gaps in rural, B40, indigenous and female learner groups. Equity moves prevent technology adoption from widening opportunity gaps.

#### What are others doing



United States E-Rate for school connectivity

Canada CanCode for broad digital access

India Atal Tinkering Labs for low-cost makerspaces

#### CONTINUATION STRATEGIES

- Sustain scholarships and targeted outreach for B40, rural, Orang Asli, and girls in STEM.






#### INCREMENTAL STRATEGIES

- Expand structured mentoring and hybrid access solutions.
- Partner media and community groups for local-language content.
- Provide device and connectivity support where needed.

#### BOLD & RADICAL STRATEGIES

- Create a Guaranteed STEM Opportunity Pathway with wraparound support and a route to priority-sector jobs for high-potential disadvantaged learners.

## STRATEGIC ENABLERS FOR IMPLEMENTATION

MIGHT F.I.R.S.T <sup>®</sup> MATRIX ENABLERS FOR STEM TALENT ATTRACTION AND MOTIVATION				
 <p><b>Funding &amp; Financing</b></p> <ul style="list-style-type: none"> <li>• Multi-year communications fund with public-private match</li> <li>• Equity supports for devices and connectivity</li> <li>• Micro-grants for youth social innovation</li> <li>• CSR and philanthropy incentives</li> </ul>	 <p><b>Infrastructure &amp; Institutions</b></p> <ul style="list-style-type: none"> <li>• STEM hubs and mobile labs</li> <li>• University-school mentoring networks including rural circuits</li> <li>• Community maker corners</li> <li>• National showcase calendar</li> </ul>	 <p><b>Regulatory &amp; Policies</b></p> <ul style="list-style-type: none"> <li>• Agency KPIs for aspiration and inclusive access</li> <li>• Simple approvals for school-industry activities</li> <li>• Recognition of service-learning and co-curricular STEM</li> <li>• Guidance on minimum orientation time and assessment</li> </ul>	 <p><b>Skills &amp; Talent</b></p> <ul style="list-style-type: none"> <li>• Training for teachers, counsellors, alumni, and youth as storytellers and mentors</li> <li>• Counsellor capability for parent engagement</li> <li>• Structured mentoring for underrepresented groups</li> <li>• Facilitation skills for community projects</li> </ul>	 <p><b>Technology &amp; Innovation</b></p> <ul style="list-style-type: none"> <li>• Immersive storytelling content and toolkits</li> <li>• Parent facing pathways app with local opportunities</li> <li>• Platforms to match students to community projects and publish outcomes</li> <li>• Hybrid and offline capable learning tech</li> </ul>

## SIGNALS TO WATCH

Practical indicators that help stakeholders monitor progress.

<b>LEADING SIGNALS</b> <b>Early indicators that respond quickly to new actions and guide mid-course adjustments.</b>	<b>LAGGING SIGNALS</b> <b>Later indicators that confirm results and show overall impact.</b>
<ul style="list-style-type: none"> <li>• Reach and engagement with the national STEM narrative across students, parents, teachers and rural audiences</li> <li>• Size and activity of role-model and mentor networks</li> <li>• Participation in STEM clubs, maker events and mission-linked service learning</li> <li>• Parent engagement at school sessions and use of parent pathway tools</li> <li>• Uptake of device and connectivity support in target groups</li> </ul>	<ul style="list-style-type: none"> <li>• Growth in learner intent to choose STEM subjects or programmes</li> <li>• Participation from underserved groups in enrichment and competitions</li> <li>• Progression into STEM streams and post-secondary STEM</li> <li>• Student projects advancing to prototype or pilot</li> </ul>

## 3.2 STEM TALENT PREPARATION

### CASE FOR ACTION

Megatrends in AI, data, smart systems and sustainability are shifting the skills frontier faster than curriculum cycles. Foundational learning and pedagogy need to keep pace, so learners build confidence, problem solving and digital comfort early. International assessment evidence shows too few students meeting minimum proficiency in mathematics, reading and science and school leaders report rising constraints from staff shortages. The immediate issues are slow refresh cycles, limited applied learning at scale, uneven teacher digital fluency and an unclear language position for global competitiveness. Opportunities include modular curricula, inquiry-rich pedagogy, structured practice with industry contexts, stronger TVET–university mobility and a common STEM Literacy core if streaming is removed. Delphi signals point to high interest in AI, data and sustainability with feasibility gaps, which supports phased enablement through curriculum, teacher capability and language support.

### WHAT TO EMPHASISE

Where to modernise curriculum and pedagogy:

- Build foundational depth in the backbone: AI and data (data analytics and visualisation, applied data science, cloud computing), smart systems (embedded systems development, IoT), and digital security (cybersecurity).
- Bring green content forward: environmental management, life cycle thinking and waste and hazardous material management in applied tasks.
- Make safety and assurance visible across labs and projects through workplace safety and health management.
- Use computational modelling and simulation to shift from rote to inquiry in science and engineering courses.
- Integrate essential skills as assessed outcomes in capstones and work-integrated learning.




## STRATEGIC OPTION 2.1

### MODERNISE AND FUTURE-PROOF THE NATIONAL STEM CURRICULUM

#### Case for action

Technology and work are changing faster than curriculum cycles. A modular, interdisciplinary and regularly refreshed curriculum keeps learning relevant and builds problem solving and digital comfort. Removing early streaming and introducing a common STEM Literacy core preserves choice while raising the national baseline.

#### What are others doing

-  Singapore Skills Framework linkages to education
-  Switzerland ERI policy emphasis on future skills
-  Finland cross-disciplinary phenomenon-based learning

#### CONTINUATION STRATEGIES

- Maintain scheduled curriculum reviews.

#### INCREMENTAL STRATEGIES

- Integrate future skills such as AI literacy, data literacy, systems thinking, entrepreneurship, and ethics.
- Pilot interdisciplinary, project-based learning with clear assessment rubrics.

#### BOLD & RADICAL STRATEGIES

- Remove early upper secondary streaming into STEM and non-STEM.
- Introduce a mandatory STEM Literacy core subject for all students through upper secondary with tiered depth bands.
- Keep advanced STEM electives open based on demonstrated mastery and interest.
- Adopt mastery-based progression and project-based assessment for the core.
- Implement a national adaptive curriculum model with rolling refresh.




## STRATEGIC OPTION 2.2

### TRANSFORM STEM TEACHER DEVELOPMENT AND PROFESSIONALISATION

#### Case for action

Teacher capability is the strongest multiplier of student outcomes. Systematic professional learning in inquiry pedagogy, assessment for learning and digital tools, plus industry immersion, upgrades classroom practice. Professional tracks help retain high-performing teachers and spread excellence.

#### What are others doing

-  Korea teacher capacity building in STEM
-  United States teacher leadership pathways
-  UK Chartered College professional standards



### STRATEGIC OPTION 2.3

#### INSTITUTIONALISE PRACTICAL, APPLIED LEARNING

##### Case for action

Doing drives understanding and interest. Structured projects that use local industry or community problems build confidence, teamwork and communication. Public showcases create accountability and raise standards.

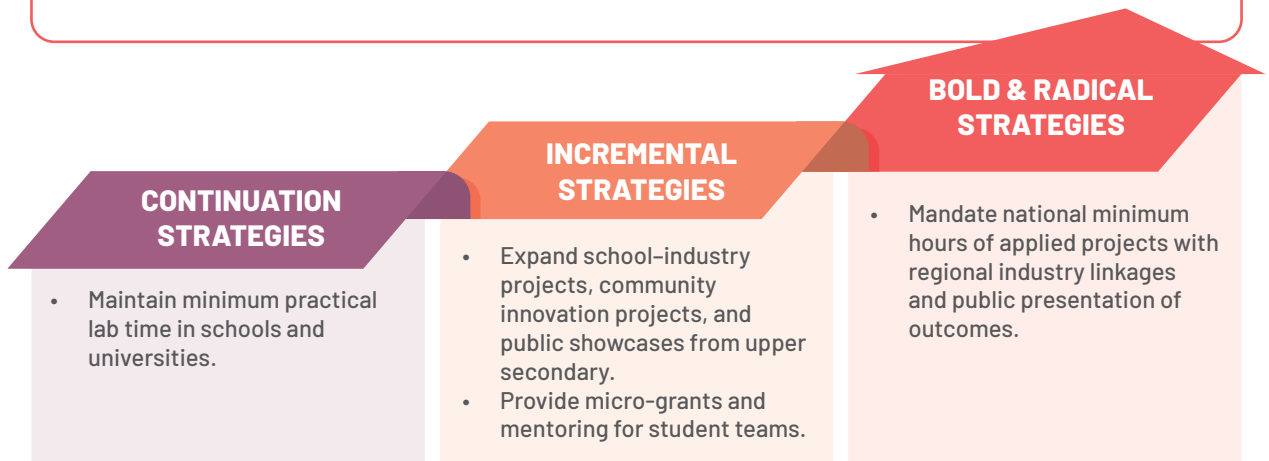
##### What are others doing



Singapore and Vietnam applied learning pathways



UK CREST Awards style project accreditation



## STRATEGIC OPTION 2.4

### ESTABLISH DUAL ACADEMIC-VOCATIONAL STEM PATHWAYS

#### Case for action

Learners need multiple routes into skilled work. Cross-credit recognition between TVET and university increases mobility and speeds progression. Upgraded facilities and shared modules align preparation with real job tasks.

#### What are others doing



Switzerland vocational excellence



Germany dual study programmes



Australia higher apprenticeships

#### CONTINUATION STRATEGIES

- Maintain selected TVET-university articulation pathways.

#### INCREMENTAL STRATEGIES

- Formalise structured dual pathways with cross-credit recognition and stackable modules.
- Upgrade TVET facilities for digital and green sectors.

#### BOLD & RADICAL STRATEGIES

- Create national integrated STEM pathways including apprenticeship degrees, enterprise-aligned diplomas, and blended academic-industry credentials.

## STRATEGIC OPTION 2.5

### ADVANCE DIGITAL AND FUTURE SKILLS LITERACY FROM EARLY EDUCATION

#### Case for action

Digital comfort is foundational for all learners. Early pathways in data, coding, cybersecurity basics and green tech awareness reduce later remediation and support industry demand. Guaranteed access to devices and connectivity keeps progress equitable.

#### What are others doing



Canada CanCode



Estonia digital skills at scale



UK computing curriculum in schools

#### CONTINUATION STRATEGIES

- Maintain existing ICT and coding modules.






#### INCREMENTAL STRATEGIES

- Introduce structured pathways in AI literacy, data literacy, cybersecurity basics, and green tech awareness.
- Guarantee device and broadband access for all learners.

#### BOLD & RADICAL STRATEGIES

- Institutionalise Digital First STEM Education with mandatory digital competencies and periodic proficiency checks through school and university.

## STRATEGIC ENABLERS FOR IMPLEMENTATION

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<ul style="list-style-type: none"> <li>• Curriculum renewal funds and competitive pilots</li> <li>• Teacher scholarships, allowances, and release time for CPD</li> <li>• Micro grants for school projects and showcases</li> <li>• Device and connectivity guarantees for learners and educators</li> </ul>	<ul style="list-style-type: none"> <li>• Curriculum innovation labs and resource banks</li> <li>• STEM Teacher Excellence Centres in each region</li> <li>• Upgraded TVET and university facilities for digital and green labs</li> <li>• Community maker labs shared by clusters of schools</li> </ul>	<ul style="list-style-type: none"> <li>• Mandated curriculum refresh cycles with rolling updates</li> <li>• Recognition of project credits and micro credentials</li> <li>• Cross credit frameworks for TVET to university mobility</li> <li>• Bilingual STEM guidance and clear language policy</li> <li>• Streaming reform and a national STEM Literacy core</li> </ul>	<ul style="list-style-type: none"> <li>• CPD in inquiry pedagogy, assessment for learning, and digital tools</li> <li>• Industry immersion modules for educators</li> <li>• Assessment literacy for project based learning</li> <li>• Joint academic industry faculty and adjuncts</li> </ul>	<ul style="list-style-type: none"> <li>• AI supported curriculum update pipeline</li> <li>• Digital learning platforms and content repositories</li> <li>• VR or AR labs for under resourced schools</li> <li>• Credentiailling for short modules and badges.</li> </ul>

## SIGNALS TO WATCH

Practical indicators that help stakeholders monitor progress.

<b>LEADING SIGNALS</b> Early indicators that respond quickly to new actions and guide mid-course adjustments.	<b>LAGGING SIGNALS</b> Later indicators that confirm results and show overall impact.
<ul style="list-style-type: none"> <li>• Schools piloting future-skills modules and interdisciplinary projects</li> <li>• Teacher CPD completion in inquiry methods, digital pedagogy and industry immersion</li> <li>• Practical learning intensity per learner and access to labs or maker kits</li> <li>• Device and broadband guarantees delivered to learners and educators</li> </ul>	<ul style="list-style-type: none"> <li>• Improved problem solving and confidence in school assessments</li> <li>• Reduced remediation for first-year STEM undergraduates</li> <li>• Growth in TVET to university cross-credit mobility</li> <li>• Share of graduates meeting baseline digital and data proficiency</li> </ul>

## 3.3 STEM TALENT DEPLOYMENT

### CASE FOR ACTION

Megatrends in energy transition and advanced manufacturing intersect with Malaysia's economic structure. Manufacturing contributes a significant share of GDP and manufactured goods drive the bulk of exports, led by electrical and electronic products. National missions such as the New Industrial Master Plan 2030 and the National Energy Transition Roadmap will expand demand for mission-ready STEM talent across green industry, electrical and electronic systems and digital services. Current issues include skills mismatch, fragmented work-integrated learning and uneven mid-career conversion routes. Opportunities include sector blueprints tied to missions, labour-market analytics for intake and placement and scaled apprenticeships and co-op models. Delphi results show many skills in high attractiveness but only moderate feasibility, which argues for phased deployment led by industry-linked practice and targeted conversion pathways.

### WHAT TO EMPHASISE

Where to align placements and conversion routes:

- Energy and engineering build-out: electrical and electronic systems, mechatronic systems integration and design, process and automation control, and advanced installation, maintenance and reliability engineering.
- Factory digitalisation: embedded systems, IoT systems and applications, plus cybersecurity for integrated IT-OT environments.
- Materials and devices: advanced materials engineering and materials science tied to priority lines in E&E, medical devices and mobility.
- Food security: food engineering and processing, precision agriculture and agriculture management in mission projects with rural pathways.
- Cross-cutting assurance: workplace safety and health, applied R&D management and strategic technology planning for firms scaling new tech.

## STRATEGIC OPTION 3.1

### ALIGN STEM DEPLOYMENT WITH NATIONAL STRATEGIC INDUSTRIES

#### Case for action

Priority sectors need predictable pipelines. Sector blueprints tied to national missions and real-time labour analytics can steer intakes and placements. Coordinated deployment reduces mismatch and accelerates productivity.

#### What are others doing



Singapore manpower foresight and sectoral councils



UK labour market intelligence dashboards

#### CONTINUATION STRATEGIES

- Maintain sector engagement and graduate employability efforts.

#### INCREMENTAL STRATEGIES

- Develop sector-specific deployment blueprints linked to national missions and digital strategies.
- Use labour market analytics to guide intake and placement priorities.

#### BOLD & RADICAL STRATEGIES

- Create a National STEM Deployment Council to steer dynamic planning with real-time labour data and adaptive targets.

## STRATEGIC OPTION 3.2

### SCALE WORK-INTEGRATED AND INDUSTRY-READY LEARNING

#### Case for action

Work exposure improves job readiness and speeds time to productivity. Structured apprenticeships, co-op models and campus-based industry labs translate theory into industry standards. Consistent placement coverage makes outcomes more equitable.

#### What are others doing



Switzerland and Germany apprenticeship models



Canada co-op education at scale

#### CONTINUATION STRATEGIES

- Continue internships and existing placements.

#### INCREMENTAL STRATEGIES

- Expand structured apprenticeships, co-op models, and dual-sector placement schemes.
- Build on-campus industry labs.

#### BOLD & RADICAL STRATEGIES

- Mandate work-integrated learning quotas so all STEM graduates complete substantial industry experience before graduation.

### STRATEGIC OPTION 3.3

#### ENABLE MID-CAREER TRANSITIONS INTO EMERGING STEM FIELDS

##### Case for action

As tasks change, workers need reliable conversion routes into growth roles. Modular bootcamps and bridging programmes de-risk transitions for individuals and firms. Incentives and placement guarantees raise completion and hiring.

##### What are others doing



Singapore mid-career pathways and allowances



UK Skills Bootcamps

##### CONTINUATION STRATEGIES

- Maintain current reskilling initiatives.

##### INCREMENTAL STRATEGIES

- Introduce modular conversion programmes and bridging courses for green, digital, and high-tech sectors.
- Offer career conversion incentives.

##### BOLD & RADICAL STRATEGIES

- Create national integrated STEM pathways including apprenticeship degrees, enterprise-aligned diplomas, and blended academic-industry credentials.

### STRATEGIC OPTION 3.4

#### BRIDGE THE GRADUATE SKILLS MISMATCH THROUGH EMPLOYABILITY STANDARDS

##### Case for action

Clear, future-facing standards align programmes with employer expectations. Benchmarks, periodic audits and transparent feedback loops drive continuous improvement. Public information on outcomes supports informed learner choice.

##### What are others doing



United States programme accountability frameworks



Australia Graduate Outcomes Survey usage

##### CONTINUATION STRATEGIES

- Maintain graduate employability targets.

##### INCREMENTAL STRATEGIES

- Introduce national employability benchmarks linked to future skills lists and industry input.
- Run periodic employability audits and feedback loops with providers.

##### BOLD & RADICAL STRATEGIES

- Publish a STEM Graduate Employability Index that compares programmes on outcomes.

## STRATEGIC OPTION 3.5

### BUILD WORKFORCE RESILIENCE TO AUTOMATION AND TASK CHANGE

#### Case for action

Automation is shifting tasks rather than only displacing jobs. Regular skills audits, cross-skilling modules and micro-credentials help workers and firms adapt. Targeted support for SMEs prevents widening capability gaps.

#### What are others doing



Singapore SkillsFuture Enterprise Credit



European Union continuous learning directives

#### CONTINUATION STRATEGIES

- Maintain digital skills upskilling offers.






#### INCREMENTAL STRATEGIES

- Systematise cross-skilling modules and multi-sector employability profiles.
- Promote continuous professional learning with micro-credentials.

#### BOLD & RADICAL STRATEGIES

- Require periodic skills audits and co-funded upskilling for STEM roles, with support for SMEs.

## STRATEGIC ENABLERS FOR IMPLEMENTATION

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<ul style="list-style-type: none"> <li>• Matching grants for internships and apprenticeships</li> <li>• Mid career learning credits for conversion programmes</li> <li>• Co funded upskilling for SMEs</li> <li>• Sector incentive funds aligned to national missions</li> </ul>	<ul style="list-style-type: none"> <li>• Industry labs on campus and shared pilot lines</li> <li>• Regional reskilling and conversion centres</li> <li>• University career hubs aligned to priority sectors</li> <li>• Labour market intelligence platforms</li> </ul>	<ul style="list-style-type: none"> <li>• Standards for work integrated learning and placement quality</li> <li>• Recognition of micro credentials in hiring and progression</li> <li>• Periodic employability reviews with public reporting</li> <li>• Flexible contracts and frameworks for rotations and secondments</li> </ul>	<ul style="list-style-type: none"> <li>• Faculty industry joint appointments and mentor pools</li> <li>• Conversion bootcamps and bridging courses</li> <li>• Continuous professional learning pathways with stackable modules</li> <li>• Career services trained in labour market analytics</li> </ul>	<ul style="list-style-type: none"> <li>• Platforms that match learners to projects, placements, and roles</li> <li>• AI guided career navigation and skills mapping</li> <li>• National employability dashboards with near real time signals</li> </ul>

## SIGNALS TO WATCH

Practical indicators that help stakeholders monitor progress.

<b>LEADING SIGNALS</b> Early indicators that respond quickly to new actions and guide mid-course adjustments.	<b>LAGGING SIGNALS</b> Later indicators that confirm results and show overall impact.
<ul style="list-style-type: none"> <li>• Coverage of work-integrated learning: internships, apprenticeships and co-op</li> <li>• Share of placements aligned to national mission sectors</li> <li>• Labour market signals: priority vacancies, wage offers and skills requested</li> <li>• Enrolment in mid-career conversion programmes for green and digital roles</li> </ul>	<ul style="list-style-type: none"> <li>• Time to first relevant job for STEM graduates</li> <li>• Placement and retention in priority sectors at 12 and 24 months</li> <li>• Employer satisfaction with graduate readiness</li> <li>• Successful career switches into high-demand STEM roles</li> </ul>

## 3.4 STEM TALENT GROWTH AND RETENTION

### CASE FOR ACTION

Megatrends point to continual task change as AI, automation and green technologies diffuse. The digital sector employs a large and growing share of the workforce and skill content continues to evolve. Malaysia's competitiveness will depend on career-long learning, visible ladders for specialists, strong research-to-industry pipelines and mobility at home and abroad. Key current issues include mid-career stagnation, uneven access to advanced learning, limited research translation and leakage of high-value talent. Opportunities include stackable micro-credentials, national specialist ladders, returnee reintegration tracks, embedded industry research roles and structured cross-sector and international rotations. Delphi findings indicate several deep domains require bachelor-plus mastery, which strengthens the case for formal growth paths and research-linked development.

### WHAT TO EMPHASISE

Where to build ladders and specialist depth:

- Biomedical and healthtech: biomedical product development and engineering, pharmaceutical sciences and multi-omics integrated analysis.
- Advanced design and verification: computational modelling and simulation for semiconductors, mobility, energy and infrastructure.
- Materials leadership: advanced materials engineering and materials science, with shared characterisation labs and industry placements.
- Green value: environmental management, life-cycle assessment and green chemistry and sustainability for export standards and circular models.
- Essentials for mobility and leadership: foresight, ethics and analytical and critical thinking as requirements for progression.

## STRATEGIC OPTION 4.1

### RETAIN HIGH-VALUE STEM TALENT IN-COUNTRY

#### Case for action

The main reasons STEM talent exits are stagnant progression, uncompetitive pay for critical roles, weak research or engineering environments, heavy administrative load and limited recognition. Retention improves when top contributors have clear advancement, autonomy to do meaningful work, competitive compensation and family friendly conditions.

#### What are others doing



Canada Research Chairs for long-term retention of research leaders



Australia Future Fellowships for mid-career retention



Germany national Tenure-Track Professorship Programme



UK Royal Society University Research Fellowships with autonomy and support



Singapore NRF Fellowships and Investigatorships that bundle funding, autonomy and prestige

#### CONTINUATION STRATEGIES

- Maintain existing retention allowances, professional accreditation incentives, and recognition awards.
- Continue flexible work pilots and childcare subsidies where available.

#### INCREMENTAL STRATEGIES

- Benchmark pay for critical STEM roles against regional peers and adjust bands where gaps are material.
- Introduce a technical specialist ladder with titles and pay parity to managerial tracks.
- Issue autonomy charters for Principal Investigators and Principal Engineers, including seed funds, faster procurement, and research manager support to cut administrative load.
- Offer structured sabbaticals and domestic secondments into mission projects with role protection on return.

#### BOLD & RADICAL STRATEGIES

- Launch five-year portable grant and position packages that follow top researchers or engineers across Malaysian institutions, with team slots and equipment budgets attached.
- Approve above-scale mission appointments for critical roles in priority sectors with performance contracts.
- Introduce equity participation or revenue-share for staff who co-found spin-offs while retaining a public appointment.

## STRATEGIC OPTION 4.2

### INSTITUTIONALISE LIFELONG STEM LEARNING PATHWAYS

#### Case for action

Rapid technology diffusion makes periodic upskilling essential. Stackable, flexible modules allow talent to refresh skills without exiting the workforce. Employer co-design improves relevance and uptake.

#### What are others doing



Singapore SkillsFuture



Switzerland lifelong learning policy

#### CONTINUATION STRATEGIES

- Continue existing short courses and micro-credentials.

#### INCREMENTAL STRATEGIES

- Scale stackable modules and flexible delivery across life stages.
- Incentivise employer participation in learning design.

#### BOLD & RADICAL STRATEGIES

- Introduce a national lifelong STEM learning guarantee that entitles periodic upskilling access.

## STRATEGIC OPTION 4.3

### STRENGTHEN ATTRACTION OF HIGH-VALUE STEM TALENT

#### Case for action

Returnees and anchor experts accelerate capability building. Structured reintegration, clear career tracks and family support raise the likelihood that high-value talent stays and contributes to national missions.

#### What are others doing



Singapore Global Talent schemes



Taiwan returnee reintegration initiatives

#### CONTINUATION STRATEGIES

- Maintain Brain Gain and returnee incentives.

#### INCREMENTAL STRATEGIES

- Provide structured reintegration tracks with career fast-tracks and housing support.
- Build peer mentoring and alumni networks for returnees.

#### BOLD & RADICAL STRATEGIES

- Create a Malaysia STEM Talent Return and Anchor Programme linked to national projects and research roles.

## STRATEGIC OPTION 4.4

### EXPAND UPWARD CAREER MOBILITY AND LEADERSHIP TRACKS

#### Case for action

Specialists need visible progression or risk plateau and exit. Dual ladders for managerial and technical experts, backed by competency standards, keep advancement transparent and merit based. Cross-sector exchanges broaden perspective.

#### What are others doing



United States technical leadership ladders



European Union professional frameworks in engineering

#### CONTINUATION STRATEGIES

- Maintain standard progression structures.

#### INCREMENTAL STRATEGIES

- Develop dual ladders for managerial or technical expert routes with recognised certifications.
- Offer cross-sector leadership exchanges.

#### BOLD & RADICAL STRATEGIES

- Establish a National STEM Professional Ladder with competency-based fast-track promotions and cross-sector mobility.

## STRATEGIC OPTION 4.5

### BUILD A ROBUST STEM RESEARCH AND DEEP TECH PIPELINE

#### Case for action

Competitiveness depends on researchers who can translate science into products, processes and policies. Early-career development, industry-embedded roles and commercialisation training shorten the path from lab to market.

#### What are others doing



Korea STEAM research fellowships



UK Catapult centres model for translation

#### CONTINUATION STRATEGIES

- Maintain research scholarships and fellowships.

#### INCREMENTAL STRATEGIES

- Expand early-career researcher development and commercialisation training.
- Set up embedded industry research roles.

#### BOLD & RADICAL STRATEGIES

- Launch a National Future Science and Technology Talent Scheme that offers integrated postgraduate-to-industry pipelines and deep tech entrepreneurship tracks.

## STRATEGIC OPTION 4.6

### FACILITATE CROSS-SECTOR AND INTERNATIONAL MOBILITY

#### Case for action

Circulation deepens skills and networks faster than static careers. Structured secondments and international rotations spread know-how across institutions and bring global practices home.

#### What are others doing








European Union Marie Skłodowska-Curie mobility



Singapore scholar and fellow networks



## STRATEGIC ENABLERS FOR IMPLEMENTATION

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<ul style="list-style-type: none"> <li>• Lifelong learning grants and tax incentives</li> <li>• Returnee and anchor talent packages</li> <li>• Leadership scholarships and fellowships</li> <li>• Research talent development funding</li> <li>• Mobility co funding for rotations and exchanges</li> </ul>	<ul style="list-style-type: none"> <li>• Regional lifelong learning hubs</li> <li>• Returnee reintegration centres and services</li> <li>• Executive leadership academies for technical leaders</li> <li>• Integrated research industry centres and shared facilities</li> <li>• Mobility facilitation offices in major institutions</li> </ul>	<ul style="list-style-type: none"> <li>• Recognition of micro credentials for progression and pay</li> <li>• Flexible contracting for rotations and secondments</li> <li>• Re entry pathways for returnees and career breaks</li> <li>• Competency based advancement frameworks</li> </ul>	<ul style="list-style-type: none"> <li>• Executive education for technical leaders</li> <li>• Research translation and commercialisation skills</li> <li>• Leadership fellowships and mentoring networks</li> <li>• Mobility readiness programmes, including cultural and project skills</li> </ul>	<ul style="list-style-type: none"> <li>• Executive education for technical leaders</li> <li>• Research translation and commercialisation skills</li> <li>• Leadership fellowships and mentoring networks</li> <li>• Mobility readiness programmes, including cultural and project skills</li> </ul>

## SIGNALS TO WATCH

Practical indicators that help stakeholders monitor progress.

<b>LEADING SIGNALS</b> Early indicators that respond quickly to new actions and guide mid-course adjustments.	<b>LAGGING SIGNALS</b> Later indicators that confirm results and show overall impact.
<ul style="list-style-type: none"> <li>• Uptake and completion of stackable micro-credentials</li> <li>• Participation in specialist or technical leadership tracks</li> <li>• Early-career research fellowships and industry-embedded research roles</li> <li>• Cross-sector secondments and international rotations started</li> </ul>	<ul style="list-style-type: none"> <li>• Retention in high-value STEM roles at two to five years</li> <li>• Translation outcomes from prototype to pilot to adoption</li> <li>• Promotions along competency-based ladders and salary progression</li> <li>• Returnee inflows that persist beyond one year</li> </ul>

## 3.5 STEM TALENT LEADERSHIP

### CASE FOR ACTION

Malaysia aims to move up the value chain in manufacturing (E&E, medical devices, pharmaceuticals), green energy, digital services and health technology, which raises the premium on anticipatory STEM leadership that can steer missions, govern emerging technologies and coordinate across institutions. Current gaps include fragmented leadership development, uneven policy literacy among technical experts, limited STEM voice in budget and regulatory decisions and mixed readiness in areas such as AI governance, data protection, biosafety and advanced materials. Opportunities include a national STEM leadership accelerator, fellowships that embed scientists and engineers in policy and regulatory roles, leadership development for mission leads and CTOs in GLCs and SMEs and targeted ASEAN or global rotations to build international presence. Delphi inputs highlight governance and regulation as pivotal enablers, supporting leadership pathways that blend technical depth, foresight, ethics and public value.

### WHAT TO EMPHASISE

Where to cultivate anticipatory leaders:

- Governance for emerging tech: AI governance and data stewardship alongside cybersecurity for trusted adoption.
- Strategy and assurance: strategic technology planning, applied R&D management and emergency and disaster preparedness for mission delivery.
- Entrepreneurial leadership in deep tech: leaders who can translate regulated science into products, with safety and public value in view.
- Futures fluency: foresight and futures thinking as a core leadership competency across ministries, GLCs and SMEs.

## STRATEGIC OPTION 5.1

### ESTABLISH A NATIONAL STEM LEADERSHIP ACCELERATOR

#### Case for action

Future missions need leaders who blend technical depth, foresight, ethics and coalition building. A focused accelerator can develop these capabilities at scale and place leaders where impact is highest.

#### What are others doing



Singapore research leadership development



UK Royal Society entrepreneurial leadership supports

#### CONTINUATION STRATEGIES

- Maintain leadership courses and fellowships.

#### INCREMENTAL STRATEGIES

- Create a STEM Leadership Accelerator with mentoring, cross-sector projects, and international exposure.

#### BOLD & RADICAL STRATEGIES

- Establish a Malaysia Future STEM Leaders Track that fast-tracks talent into national innovation roles and public leadership.

## STRATEGIC OPTION 5.2

### CULTIVATE STEM CHANGEMAKERS FOR SOCIETAL TRANSFORMATION

#### Case for action

Grassroots innovators and youth teams deliver practical solutions and build public trust in technology. National challenges and incubation convert local ideas into visible impact.

#### What are others doing



Vietnam community innovation hubs



Global social innovation competitions

#### CONTINUATION STRATEGIES

- Continue youth innovation programmes.

#### INCREMENTAL STRATEGIES

- Scale national changemaker challenges and embed STEM-for-society modules.
- Provide incubation and small grants.

#### BOLD & RADICAL STRATEGIES

- Launch STEM for National Impact Fellowships that fund and showcase community solutions in climate, digital inclusion, and health.

## STRATEGIC OPTION 5.3

### POSITION STEM TALENT IN NATIONAL DECISION-MAKING

#### Case for action

Policy quality improves when technical expertise is present and empowered. Formal roles, training in evidence use and clear engagement protocols strengthen decisions on emerging technologies and national missions.

#### What are others doing



United States and United Kingdom fellowship models for scientists in government



OECD practice on science advice to policy

#### CONTINUATION STRATEGIES

- Maintain ad-hoc expert engagement in policymaking.

#### INCREMENTAL STRATEGIES

- Formalise STEM participation in policy committees, sector councils, and mission teams.
- Provide policy literacy and evidence-use training.

#### BOLD & RADICAL STRATEGIES

- Mandate structured youth STEM representation in national strategic platforms with clear roles in blueprint design and review.

## STRATEGIC OPTION 5.4

### BUILD A NATIONAL TECHNOPRENEURIAL LEADERSHIP PIPELINE

#### Case for action

Deep tech ventures need leaders who can navigate science, product and markets. Venture-building with investor access and international pathways accelerates team formation and scaling.

#### What are others doing



Singapore deep tech accelerators



United States SBIR or innovation corps style pathways

#### CONTINUATION STRATEGIES

- Maintain entrepreneurship training and incubators.

#### INCREMENTAL STRATEGIES

- Create structured venture-building programmes for STEM fields with investor access and market validation.
- Support university spin-offs.

#### BOLD & RADICAL STRATEGIES

- Launch a National Deep Tech Talent Builder with seed support, leadership coaching, and cross-border scaling pathways.

## STRATEGIC OPTION 5.5

### GLOBALISE MALAYSIAN STEM LEADERSHIP TALENT

#### Case for action

International exposure grows capability and influence. Structured inbound and outbound placements create networks that benefit Malaysian institutions and firms.

#### What are others doing



ASEAN science diplomacy programmes



International research leadership networks

#### CONTINUATION STRATEGIES

- Continue international scholarships and exchanges.






#### INCREMENTAL STRATEGIES

- Expand global leadership fellowships and cross-border placements.
- Build regional platforms for Malaysians to chair and co-lead initiatives.

#### BOLD & RADICAL STRATEGIES

- Position Malaysia as a regional hub for STEM leadership with structured inbound-outbound circulation and co-led research and development missions.

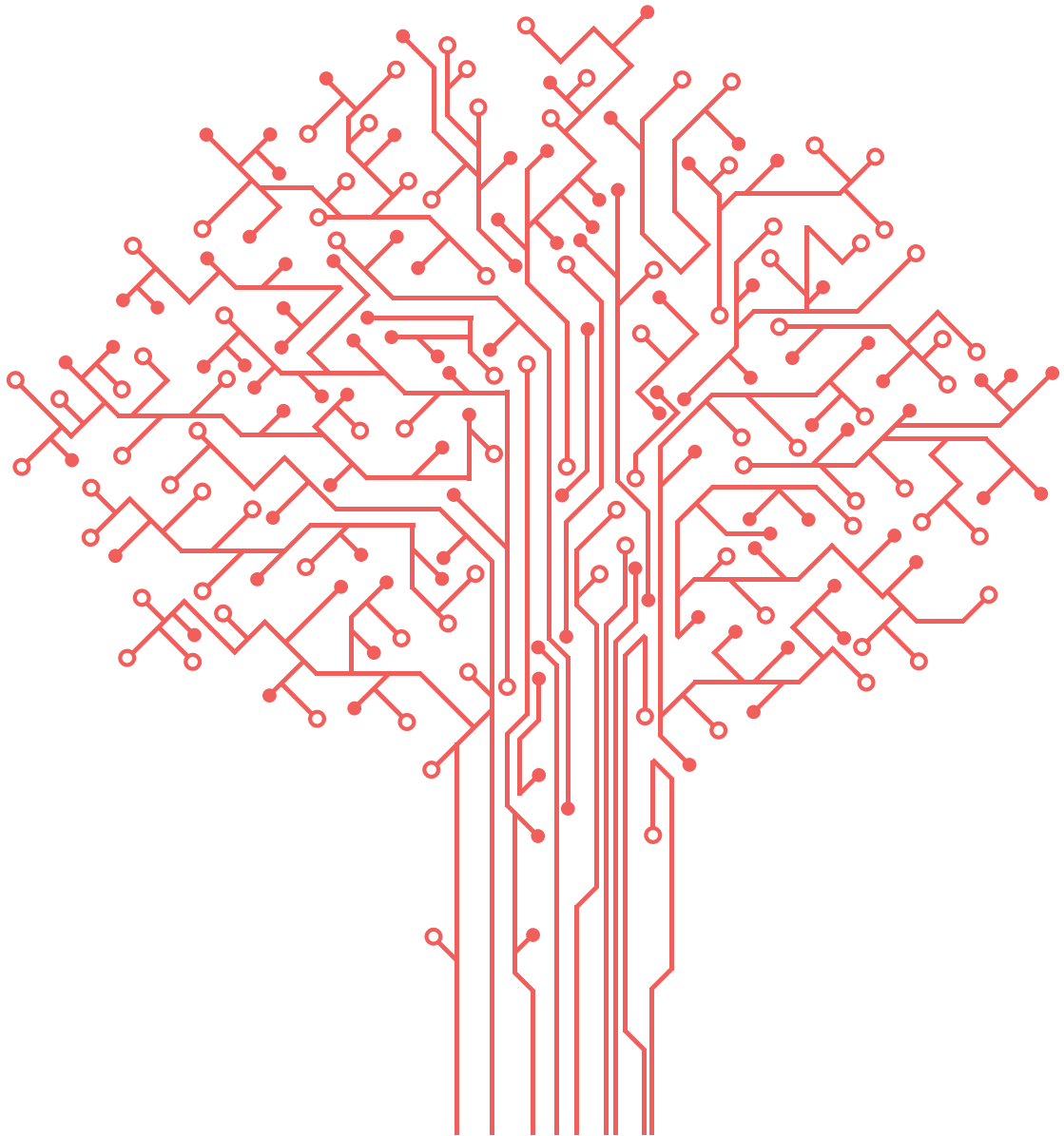
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MIGHT F.I.R.S.T. <sup>®</sup> MATRIX ENABLERS FOR STEM TALENT ATTRACTION AND MOTIVATION				
 <b>Funding &amp; Financing</b>	 <b>Infrastructure &amp; Institutions</b>	 <b>Regulatory &amp; Policies</b>	 <b>Skills &amp; Talent</b>	 <b>Technology &amp; Innovation</b>
<ul style="list-style-type: none"> <li>• Leadership development funds for cross sector cohorts</li> <li>• Micro grants for community changemakers</li> <li>• Seed funding and co investment for deep tech ventures</li> <li>• Co funding for international placements and fellowships</li> </ul>	<ul style="list-style-type: none"> <li>• National STEM Leadership Academy</li> <li>• Community innovation hubs for local problem solving</li> <li>• Venture building networks and accelerators</li> <li>• Malaysia STEM Global Leadership Centre for international engagement</li> </ul>	<ul style="list-style-type: none"> <li>• Formal roles for STEM talent in policy and mission bodies</li> <li>• University spin off facilitation and IP frameworks</li> <li>• Flexible re entry provisions after global assignments</li> </ul>	<ul style="list-style-type: none"> <li>• Foresight, scenario thinking, ethics, and policy literacy</li> <li>• Entrepreneurial leadership and venture skills</li> <li>• Cross sector and cross border fellowships and exchanges</li> </ul>	<ul style="list-style-type: none"> <li>• Leadership profiling and learning tools</li> <li>• Civic tech platforms for co creation with communities</li> <li>• Innovation matchmaking platforms and virtual global networks</li> </ul>

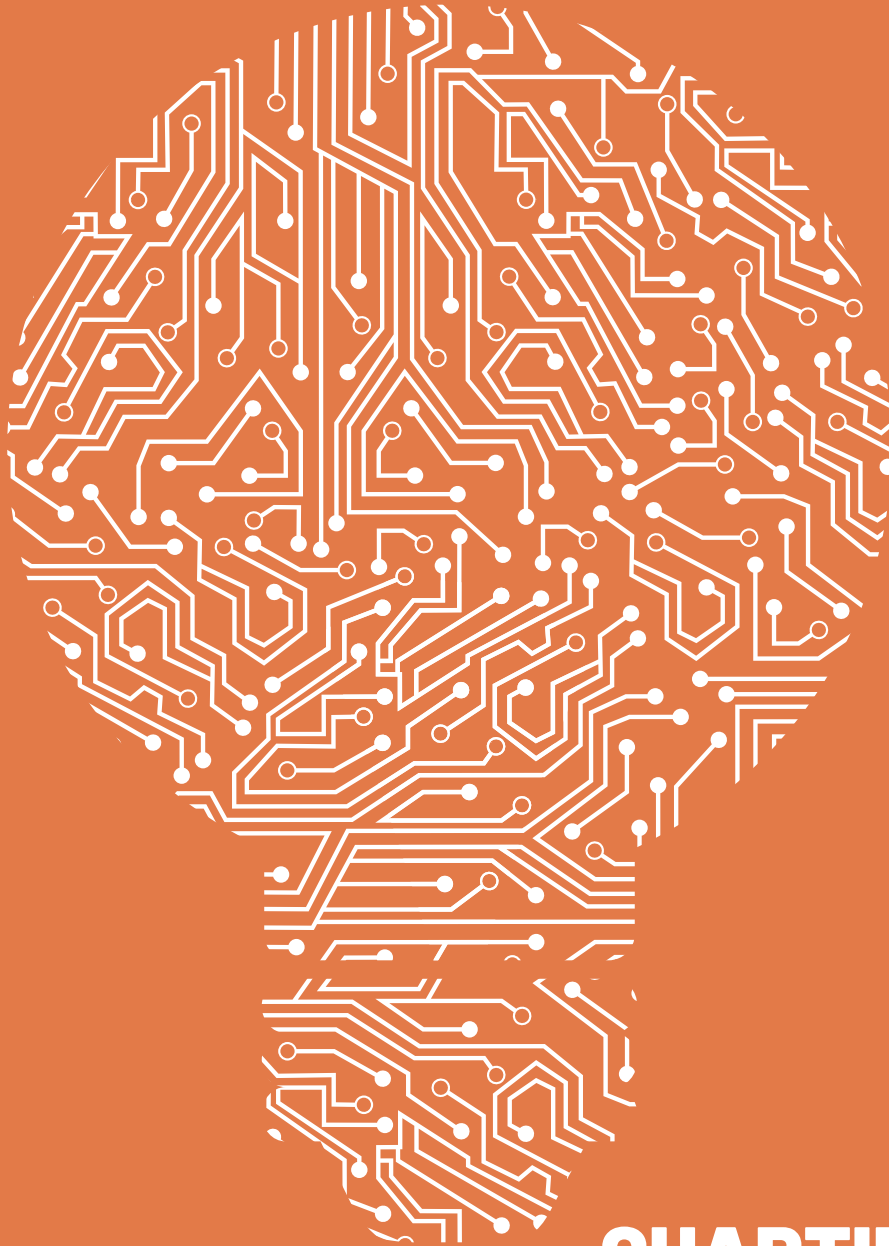
## SIGNALS TO WATCH

Practical indicators that help stakeholders monitor progress.

<b>LEADING SIGNALS</b> Early indicators that respond quickly to new actions and guide mid-course adjustments.	<b>LAGGING SIGNALS</b> Later indicators that confirm results and show overall impact.
<ul style="list-style-type: none"> <li>• Participation in STEM leadership accelerators and fellowships</li> <li>• Delivery of foresight and policy literacy modules to emerging leaders</li> <li>• STEM seats in national councils, mission teams and advisory groups</li> <li>• Venture-building enrolments and investor engagements for deep tech</li> </ul>	<ul style="list-style-type: none"> <li>• Growth of deep tech founders and follow-on funding events</li> <li>• Recognised roles in regional or global programmes</li> <li>• Use of foresight outputs in national strategies and programme refreshes</li> <li>• Public recognition for STEM leaders who drive mission outcomes</li> </ul>



# CHAPTER 4



## **CHARTING MALAYSIA'S STEM FUTURE**

## CHARTING MALAYSIA'S STEM FUTURE

This final chapter draws the threads together. The earlier analysis identified technologies, prioritised skills and set out practical options across the talent journey. Here we convert those insights into a clear close: what to prioritise, why sequence matters and how to move from recommendations to results without losing sight of inclusion, regional balance and national competitiveness to 2040. The intent remains advisory. The aim is to help decision makers act with confidence while staying adaptive as conditions evolve.

Across the horizon scanning, Delphi work and engagements, a consistent message emerges. Early moves that widen the pipeline and raise visibility create momentum, while deeper reforms in curriculum, pedagogy, applied learning and language readiness build capability at scale. Over time, institutionalised lifelong learning, research translation, mobility and leadership development keep talent in Malaysia and lift firms into higher value activities.

This chapter distils priorities, reflecting policy support needs and stakeholder views on impact, feasibility and urgency. The chapter also sets the way forward by restating the advisory purpose of the report, noting its boundaries and outlining practical stewardship for government, industry and education partners. Together, a concise bridge from evidence to implementation, enabling conditions and simple signals that allow learning and course correction over time is presented for users of this report to adopt and adapt.

“

Over time, institutionalised lifelong learning, research translation, mobility and leadership development keep talent in Malaysia and lift firms into higher value activities.

”

## 4.1 PRIORITISING ACTION FOR MALAYSIA'S FUTURE STEM TALENT

### WHAT TO DO FIRST, WHAT TO BUILD NEXT

Malaysia cannot act on everything at once. Prioritising where to begin helps convert intent into early results while longer horizon reforms take root. This section draws on the policy support analysis and a workshop survey of policymakers, industry and academia to guide where to focus first and how to pace delivery to 2040.

#### PRIORITY 1

### POLICY SUPPORT SHOULD STRENGTHEN TECHNOLOGY, DIGITAL AND INNOVATION ECOSYSTEMS

Across the prioritised STEM skills, the centre of gravity is clear. A large majority, twenty three of forty, depend first on strong technology and innovation infrastructure. The skills that matter most for Malaysia's next wave of growth include applied data science, cybersecurity, cloud and network systems, IoT, renewable and electrical systems, quantum, AI governance and advanced materials. These areas cannot mature without access to modern tools, secure networks, high quality datasets, shared laboratories and safe testbeds. The policy signal is to build common platforms that many users can share rather than a patchwork of small projects. National data resources, cloud credits for learning and research, open testbeds for energy, mobility and manufacturing and a pooled AI compute facility would lift capability across multiple domains at once.

#### POLICY SUPPORT NEEDED TO EQUIP FUTURE TALENT IN MALAYSIA WITH PRIORITISED STEM SKILLS

 <b>Funding &amp; Financing</b>	 <b>Regulatory &amp; Policies</b>	 <b>Skills &amp; Talent</b>	 <b>Technology &amp; Innovation</b>
<ul style="list-style-type: none"> <li>• Pharmaceutical Sciences</li> <li>• Synthetic Biology</li> </ul>	<ul style="list-style-type: none"> <li>• Artificial Intelligence &amp; Machine Learning Modelling</li> <li>• Data Analytics &amp; Visualisation</li> <li>• Generative AI &amp; Large Language Models</li> <li>• Computational Modelling &amp; Simulation</li> <li>• Mechatronic Systems Integration &amp; Design</li> <li>• Process &amp; Automation Control</li> <li>• Biomedical Product Development &amp; Engineering</li> </ul>	<ul style="list-style-type: none"> <li>• Advanced Installation, Maintenance &amp; Reliability Engineering</li> <li>• Civil &amp; Structural Engineering Management</li> <li>• Geospatial Analytics</li> <li>• Waste &amp; Hazardous Material Management</li> <li>• Food Engineering &amp; Processing</li> <li>• Clinical Practice</li> <li>• Material Science</li> <li>• Good Laboratory Practice Management</li> </ul>	<ul style="list-style-type: none"> <li>• Applied Data Science</li> <li>• Cybersecurity</li> <li>• Electrical &amp; Electronics Systems</li> <li>• Renewable Energy Systems Engineering</li> <li>• Green Chemistry &amp; Sustainability</li> <li>• Agricultural Management</li> <li>• Sustainable Farming</li> <li>• Advanced Materials Engineering</li> <li>• IoT Systems &amp; Applications</li> <li>• Applied Research &amp; Development Management</li> <li>• Cloud Computing</li> <li>• AI Governance</li> <li>• Network &amp; Computer Systems Administration</li> <li>• Life Cycle Assessment</li> <li>• Precision Agriculture</li> <li>• Multi-omics Integrated Analysis</li> <li>• Embedded Systems Development</li> <li>• Programming &amp; Coding</li> <li>• Workplace Safety &amp; Health Management</li> <li>• Strategic Technology Planning</li> <li>• Quantum Science &amp; Engineering</li> <li>• Emergency &amp; Disaster Preparedness</li> <li>• Environmental management</li> </ul>

## PRIORITY 2

### PEOPLE TO DRIVE THE STEM SKILLS

People and practice remain pivotal. Several priority skills point to the need to raise educator and practitioner capability in reliability engineering, geospatial analytics, materials science, clinical practice and good laboratory management. This calls for continuous professional development that blends inquiry teaching with industry tools, joint faculty appointments with employers and recognition of micro credentials that document progression. In the laboratory sciences, strong practice in safety, quality assurance and ethics is as important as technical know-how.

## PRIORITY 3

### ENABLING REGULATION ACCELERATES SAFE ADOPTION

Regulation should act as an enabler. Skills clustered under AI, modelling and simulation, mechatronics, process control and biomedical engineering require clear rules on data quality, privacy, model validation, safety and liability. Practical steps include regulatory sandboxes, standard methods for testing algorithms and devices, guidance on the use of synthetic data and streamlined pathways for certification and accreditation. When rules are predictable and proportionate, educators and firms can innovate with confidence and shorten the time from training to application.

## PRIORITY 4

### CATALYTIC FUNDING WHERE COSTS AND RISKS ARE HIGHEST

Funding and financing matter most where capital intensity and biosafety requirements are high. Pharmaceutical sciences and synthetic biology, for example, need catalytic investment to access specialised equipment, reagents and appropriate containment facilities and to support regulatory science capability. Co-investment models that combine public grants with industry contributions, vouchers for SME participation in shared labs and outcome-based missions can stretch resources while building real capability.

## PRIORITY 5

### NATIONWIDE ACCESS SO BENEFITS REACH EVERY COMMUNITY

Geography matters. Investments in platforms and rules should translate into access beyond urban centres. Extending secure connectivity, enabling remote and hybrid participation and deploying mobile labs and maker spaces will ensure that rural and underserved communities' benefit. Open access policies for national platforms, with fair usage and data governance, can keep entry barriers low for schools, TVET centres, universities and SMEs.

## FROM ENABLING PLATFORM TO SEQUENCE OF ACTION

With the enabling platform defined by the five policy support priorities, the next step is to set an order of effort that converts intent into delivery. The priorities that follow focus on where early moves can create momentum while deeper reforms build capability at scale, balancing impact, feasibility and urgency across the talent journey. This phased approach links shared infrastructure, smart rules, people capability, catalytic finance and broad access to practical actions so that quick wins widen participation, sustained improvements lift quality and longer-term investments secure durable change.

A stakeholder assessment to prioritise the strategic options where efforts should be focused to strengthen Malaysia's future STEM talent indicates where early effort will deliver the greatest effect, balancing impact, feasibility and urgency across the talent journey. The signal is clear as shown in Figure 4.2. Move quickly on STEM Talent Attraction and Motivation to create momentum now, invest steadily in STEM Talent Preparation to lift quality at scale and phase STEM Talent Deployment as well as Growth and Retention as capacity deepens, with STEM Leadership built once the foundations are reliable.

### Prioritising Where Efforts Should Be Focused To Strengthen Malaysia's Future STEM Talent

#### MOST IMPACTFUL

- 1st STEM Talent Preparation
- 2nd STEM Talent Attraction & Motivation
- 3rd STEM Talent Growth & Retention
- 4th STEM Talent Deployment
- 5th STEM Talent Leadership

#### MOST FEASIBLE

- 1st STEM Talent Attraction & Motivation
- 2nd STEM Talent Preparation
- 3rd STEM Talent Leadership
- 4th STEM Talent Deployment
- 5th STEM Talent Growth & Retention

#### MOST URGENT

- 1st STEM Talent Attraction & Motivation
- 2nd STEM Talent Preparation
- 3rd STEM Talent Growth & Retention
- 4th STEM Talent Deployment
- 5th STEM Talent Leadership

Figure 4.2 Prioritising where efforts should be focused to strengthen Malaysia's future STEM talent.

## **ACTION 1**

### **MOVE FAST ON STEM TALENT ATTRACTION AND MOTIVATION**

Attraction and motivation are both feasible and urgent. A unified national narrative, visible and relatable role models, active parent and community engagement and practical access measures such as devices and connectivity can be deployed quickly. These steps widen participation, improve confidence and create early wins while deeper reforms take root.

## **ACTION 2**

### **INVEST IN STEM TALENT PREPARATION FOR SYSTEM WIDE IMPACT**

Preparation carries the greatest impact on the system over time. Modern curricula, strong pedagogy, applied and project learning and language readiness build deep technical and interdisciplinary capability. Investment here shapes quality at scale and underpins the other themes.

## **ACTION 3**

### **PHASE STEM TALENT GROWTH AND RETENTION WITH SUSTAINED SUPPORT**

Growth and retention require patient investment and close partnership with employers and institutions. Lifelong learning, specialist ladders, returnee reintegration and research translation depend on stable funding, clear pathways and consistent standards. Early design work can begin now, with staged expansion as capability grows.

## **ACTION 4**

### **SEQUENCE STEM TALENT DEPLOYMENT WITH STRONGER EMPLOYER PARTNERSHIPS**

Deployment improves when preparation quality rises and employer coordination strengthens. Aligning intakes and placements to mission sectors, scaling work-based learning and enabling mid-career conversion call for labour market analytics, shared placement infrastructure and industry commitment.

## **ACTION 5**

### **BUILD STEM TALENT LEADERSHIP ON STRONG FOUNDATIONS**

Leadership remains important for governance, ethics and international presence, yet it is most effective when built on steady foundations. Develop leadership programmes once attraction and preparation are delivering reliably, so emerging leaders have strong systems to lead.

## 4.2 WAY FORWARD FOR MALAYSIA'S FUTURE STEM TALENT

Malaysia's way forward is to mobilise the future STEM skills identified by this foresight, so they shape what is taught, how people are hired and upskilled and where innovation is directed. The skills map should guide curriculum and assessment, teacher development, equipment and shared platforms, employer demand signals and targeted finance. Priority skills in AI and data, smart systems, sustainability and advanced manufacturing need translating into clear competency standards, stackable credentials and applied projects in education and into recruitment, apprenticeships and mid-career conversion routes in industry. Agencies align standards and incentives, institutions embed pathways and employers specify skill profiles and provide meaningful practice. Progress is tracked through a small set of skill-based indicators and refreshed through regular horizon scanning so the skills outlook stays current. The aim is a coherent national effort that turns a skills forecast into capability, opportunity and competitiveness across all regions.

### ACT NOW ON THE MOST READY, HIGH IMPACT SKILLS



A small set of skills is both highly attractive and feasible to scale quickly. These include Data Analytics and Visualisation, Workplace Safety and Health Management, Advanced Installation, Maintenance and Reliability Engineering and Environmental Management. They fit existing programmes and platforms, can be taught with current facilities and meet immediate employer demand. Use them for fast wins that build confidence and create momentum while deeper reforms take hold.

### BUILD ENABLERS TO UNLOCK THE BIGGEST OPPORTUNITY SET



Most priority skills sit in the high-attractiveness but moderate-feasibility space. This group covers the core of Malaysia's growth agenda from AI modelling, cloud and cybersecurity through mechatronics, process control, renewable energy systems, geospatial analytics, green chemistry, food engineering, precision agriculture and biomedical product development. The constraint is not interest but readiness. Invest in teacher capability, shared labs and testbeds, secure data access, co-developed curricula and work-integrated learning to lift feasibility at scale.

### NURTURE EMERGING FRONTS THROUGH FOCUSED PILOTS



A few skills are highly attractive yet currently hard to deliver at scale. Quantum Science and Engineering is emblematic. Priorities here are focused pilots, international partnerships, research scholarships and careful staging of facilities and standards. Keep expectations realistic, connect pilots to mission needs and review progress annually to decide whether to expand, sustain, or pause.

The prioritisation reflects current evidence and delivery readiness. Several skills not prioritised in this study may still yield significant economic value as technologies and markets evolve. Maintain an active watchlist, commission targeted scans, and run time-bound pilots where signals strengthen. This ensures Malaysia can move early when value is clear and capability can be built efficiently.

## WATCHLIST

### STEM SKILLS THAT MIGHT NEED FURTHER EXPLORATION

The following 18 STEM Skills were not prioritised in the Delphi Survey as it did not meet the minimum threshold for sample size but warrant close monitoring for potential future economic value. Keep them on a rolling watchlist and test where signals strengthen.



#### Aerospace systems maintenance and integration

**Why it could matter:** Expands maintenance, repair and overhaul (MRO) capability, safety and certification depth, enabling higher value contracts and regional hub roles.



#### Data engineering

**Why it could matter:** Builds the pipelines and real time data flows that let analytics and AI deliver impact at scale.



#### Data governance

**Why it could matter:** Enables trusted data sharing, compliance and interoperability for national platforms across health, finance and public services.



#### Digital and control systems engineering

**Why it could matter:** Modernises process control and operational technology (OT) integration in brownfield plants, raising productivity, quality and uptime.



#### Diagnostic and imaging expertise

**Why it could matter:** Supports earlier detection, remote diagnostics and clinical quality, and builds medical technology localisation.



#### Energy trading and hedging strategies

**Why it could matter:** Manages price volatility and improves portfolio economics for utilities, generators and large energy users.



#### Kinematic modelling

**Why it could matter:** Improves precision motion for robotics and autonomous systems in factories, logistics and medical devices.



#### Marine and offshore engineering

**Why it could matter:** Enables offshore wind, subsea operations and safe oil and gas decommissioning while strengthening the maritime economy.



#### Mathematical and statistical modelling

**Why it could matter:** Optimises energy dispatch, financial risk, hospital demand and climate risk planning, improving efficiency and resilience.



#### One Health and zoonotic disease management

**Why it could matter:** Integrates human, animal and environmental surveillance to prevent outbreaks and protect trade and tourism.



#### Patient centred services

**Why it could matter:** Redesigns care pathways and digital front doors to reduce waiting times and lift outcomes and productivity.



#### Quality, Health, Safety and Environment compliance

**Why it could matter:** Protects licence to operate, meets global supplier standards and reduces incidents and costs.



#### Software development and testing

**Why it could matter:** Delivers secure, reliable systems for critical infrastructure and regulated sectors, enabling exportable digital products.



#### Space systems engineering

**Why it could matter:** Builds capacity for small satellites, Earth observation and satellite communications that support agriculture monitoring, disaster response and connectivity.



#### Surface and packaging engineering

**Why it could matter:** Improves durability and reliability in semiconductors, batteries and medical technologies through advanced coatings and device packaging.



#### Technology risk management

**Why it could matter:** Controls risk across cyber, third party, AI models and operational technology, strengthening trust and continuity.



#### UX engineering

**Why it could matter:** Drives adoption and accessibility of Malaysian digital products and services, improving user satisfaction and market reach.



#### System architecture and designing

**Why it could matter:** Provides end to end blueprints for complex systems, aligning business needs with technical components to improve scalability, interoperability, security and maintainability.

**Process to act on the watchlist:** Scan annually for demand, wage, investment and standards signals. If ad hoc triggers arise, such as major investments or new standards, initiate a rapid feasibility scan and a 6 to 12 months pilot with an industry partner.

## TRANSLATE SKILLS INTO SECTOR PACKAGES



Organise delivery by sector so skills become jobs and productivity. For energy transition, combine Renewable Energy Systems Engineering, Electrical and Electronics Systems, Environmental Management, Life Cycle Assessment and reliability practice. For E&E and advanced manufacturing, pair Embedded Systems, IoT Systems, Mechatronic Integration, Process and Automation Control and Advanced Materials. For digital services, align AI and Data, Cybersecurity, Network and Systems Administration and Cloud Computing. For health and bio, link Pharmaceutical Sciences, Good Laboratory Practice, Multi-omics and Biomedical Product Development with clinical partners. For food security, connect Precision Agriculture, Food Engineering, Sustainable Farming and Agriculture Management.

## MATCH KNOWLEDGE LEVELS TO ROLES



Use a tiered approach to mastery. Bachelor's level should be the baseline for most priority skills that flow into production roles. Postgraduate training is essential in deep domains such as multi-omics, synthetic biology, quantum and advanced materials where research and standards drive entry. TVET and advanced diplomas supply the technician backbone in installation, reliability, process control, coding for deployment and network administration. Align admissions, scholarships and micro-credentials to these tiers so supply meets role requirements.

## SEQUENCE DELIVERY AND TRACK WHAT MATTERS



Phase actions so early wins widen participation and signal intent, while system improvements in curriculum, pedagogy, applied learning and language readiness raise quality at scale. Use a small signal set to track reach, feasibility lift, placement into mission sectors and translation from prototype to pilot. Keep foresight active so the skills map and programmes refresh as technologies, markets and standards evolve.

## FROM FORESIGHT TO NATIONAL CAPABILITY



As previously mentioned, this foresight report is intended to inform towards anticipatory decision making. It offers signals and practical options so decision makers can act with confidence as conditions evolve. Policies, programmes and budgets will be shaped through the appropriate channels. The value here is clarity on what matters and how choices can be assembled into workable packages for different sectors and places.

The analysis reflects a defined period, a structured skills assessment and engagements with stakeholders. Technologies and labour markets will continue to shift and some datasets have gaps or lags. Treat the recommendations as a menu. Pilot where helpful, pair actions with the MIGHT F.I.R.S.T<sup>®</sup> Matrix enablers and track a small set of leading and lagging signals. Where major investment or regulatory change is contemplated, commission focused feasibility work. Refresh the skills outlook through regular horizon scanning so priorities remain relevant.

## WHY TIMELY ACTION MATTERS



Acting now widens participation, lifts confidence and signals commitment to learners, employers and investors. Steady improvements in curriculum, pedagogy, applied learning and language readiness build capability at scale. Over time, lifelong learning, research translation, mobility and leadership development keep talent in Malaysia and move firms into higher value activities. The gains include productivity growth, quality jobs across regions, stronger participation in global value chains and greater resilience to shocks. Delay carries costs through deeper skills mismatches, slower technology adoption, widened inequalities and lost ground in strategic industries.

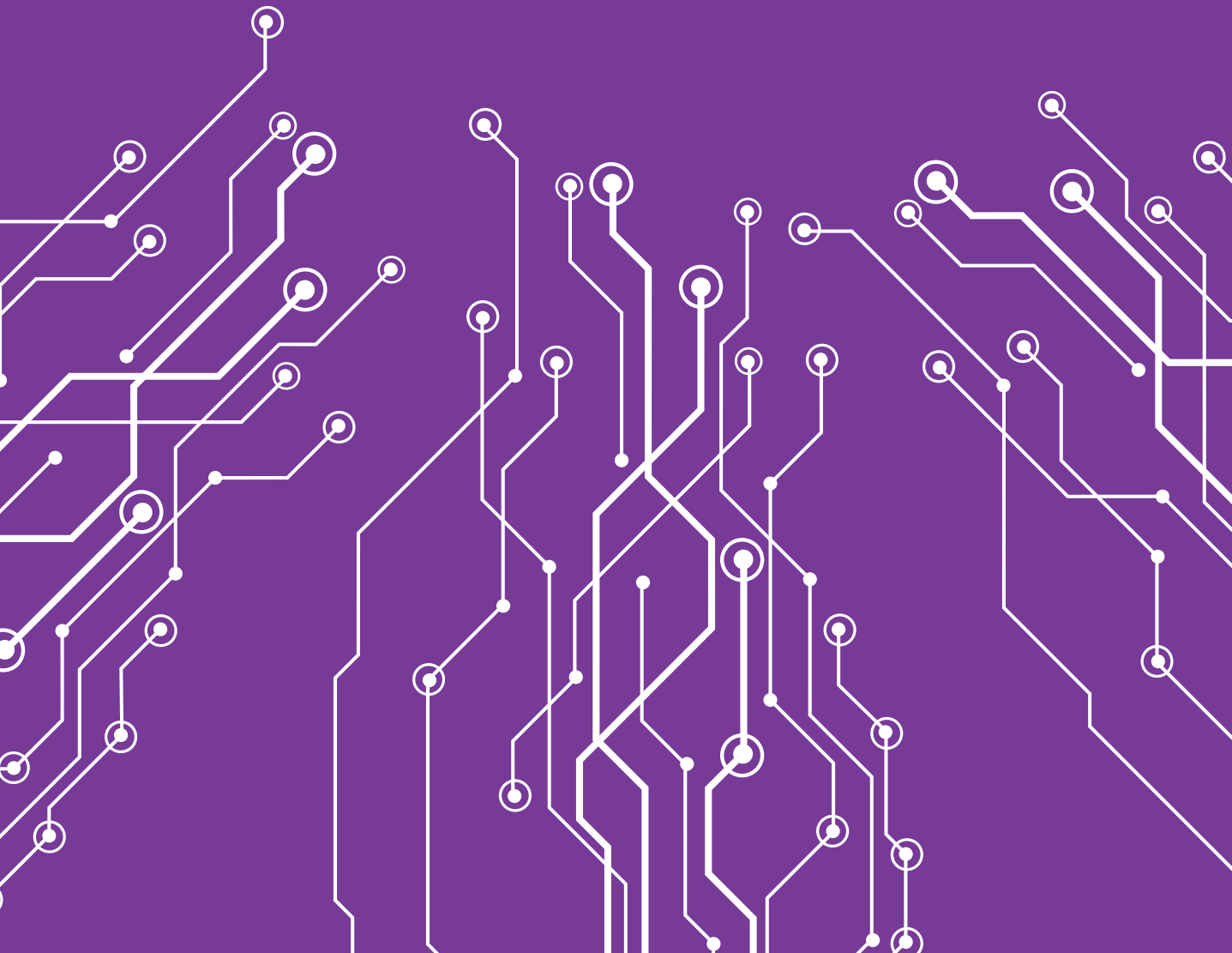
## STEWARDSHIP THAT CATALYSES EFFORTS



Delivery depends on clear roles and purposeful collaboration. The science and technology portfolio convenes on emerging technologies, standards and foresight. Education ministries steward curriculum, pedagogy, language readiness and pathways across schools, TVET and universities. Economic and industry portfolios align deployment to national missions and broker employer participation. Funding and quality agencies anchor finance, incentives and assurance. Universities and TVET providers modernise curricula, professionalise teaching and expand applied projects with cross credit recognition. Industry partners co design programmes, provide meaningful work exposure, support mid-career conversion routes and accelerate research translation. States, districts and communities widen access, mobilise mentors and showcase outcomes so benefits reach every region.

The way forward requires a whole-of-nation effort. Begin with actions that expand reach and trust, deepen capability through modernised learning and practice and anchor progress by connecting future skills to mission industries and career growth. With steady delivery and shared stewardship, Malaysia can turn a forward view of STEM skills into capability, opportunity and competitiveness to 2040.

# APPENDICES



## APPENDIX A: WORKING DEFINITIONS

TERM	DEFINITION	REFERENCE
Essential skills	Essential skills are non-technical competencies that complement STEM skills. They are critical for employability, support career mobility and remain relevant across all industries and technology divisions.	Developed by MIGHT and adapted from Global STEM Alliance, 2016, Singapore Skills Framework, 2016 and Future Skills Framework, 2024.
Industry	An economic activity or industry consists of a group of establishments engaged in the same, or similar, kinds of activity.	Department of Statistics Malaysia. (2008). Malaysia Standard Industrial Classification (MSIC) 2008.
MIGHT F.I.R.S.T® Matrix	The matrix is a checklist to assist assessing implication and defining possible responses through exploration from five perspectives. The five perspectives are: <ul style="list-style-type: none"> <li>• Funding and Financing,</li> <li>• Infrastructure &amp; Institution,</li> <li>• Regulatory and Policy,</li> <li>• Skills and Talents, and</li> <li>• Technology and Innovation.</li> </ul>	Developed by MIGHT, 2018.
New and emerging technology	Technologies that are still in development or recently developed technologies that are in early stage of adoption. These technologies might not be fully established or may already be available and are gaining traction with significant potential in terms of impact, innovation and application.	Developed by MIGHT and adapted from OECD. (2019). OECD Science, Technology and Innovation Outlook 2018: Adapting to Technological and Societal Disruption. OECD Publishing.
Qualification Level	As defined in Malaysian Qualification Framework (MQF), the MQF maintains eight levels of learning achievement. These are Certificates (Level 1-3), Diploma and Advanced Diploma (Level 4-5) and Bachelor, Master and Doctoral degrees (Level 6, 7 and 8). Post-doctoral degrees are not included in the Framework.	Ministry of Higher Education (MOHE). (2017). Malaysian Qualifications Framework (MQF) 2nd Edition.
Skill	Skill is defined as the ability to carry out the tasks and duties of a given job.	Ministry of Human Resource. (2020). Malaysia Standard Classification of Occupations (MASCO).
Skill Certificate Level	As defined in National Occupational Skills Standard (NOSS), the levels are categorised as follows: <ul style="list-style-type: none"> <li>• Level 5: Skilled in applying various fundamental principles and complex techniques across a broad scope, often in unpredictable situations. Holds high responsibility and autonomy, being accountable for both personal work and the work of others, as well as resource allocation. Also responsible for analysis, diagnosis, design, planning, management and evaluation.</li> <li>• Level 4: Skilled in performing a wide range of technical and professional activities within various scopes and contexts. Holds high responsibility and autonomy, often responsible for the work of others and resource allocation.</li> <li>• Level 3: Skilled in performing a range of activities in various contexts, most of which are complex and uncommon. Holds high responsibility and autonomy, while supervising and providing guidance to others.</li> <li>• Level 2: Skilled in performing a range of activities in various contexts, some of which are uncommon and require responsibility and autonomy.</li> <li>• Level 1: Skilled in performing a range of activities, most of which are common and predictable.</li> </ul>	Ministry of Human Resource. (2025). National Occupational Skills Standard (NOSS).

TERM	DEFINITION	REFERENCE
STEM Field	<p>All TVET (Technical and Vocational Education and Training) programs at the Malaysian Skills Certificate (Sijil Kemahiran Malaysia) Level 3 and above are categorised as STEM programs. The STEM fields are also based on the National Education Code (NEC) 2010 Manual, covering fields numbered 4 to 8 as follows:</p> <ul style="list-style-type: none"> <li>4 - Science, Mathematics and Computing</li> <li>5 - Engineering, Manufacturing and Construction</li> <li>6 - Agriculture and Veterinary</li> <li>7 - Health and Welfare</li> <li>8 - Services</li> </ul> <p>If there are any TVET programs that include Social Sciences, they are also considered STEM programs even though they are not listed under the NEC codes. Meanwhile, according to the National Education Code (NEC) 2020 Manual, STEM fields are categorised under fields numbered 5 to 10 as follows:</p> <ul style="list-style-type: none"> <li>5 - Natural sciences, mathematics and statistics</li> <li>6 - Information and communication technologies</li> <li>7 - Engineering, manufacturing and construction</li> <li>8 - Agriculture, forestry, fisheries and veterinary</li> <li>9 - Health and welfare</li> <li>10 - Services</li> </ul>	Kementerian Sains, Teknologi dan Inovasi (MOSTI). (2018). Pelan Tindakan Strategik STEM Nasional 2018-2025.
STEM skill area	Refers to a broad category of related STEM skills that are grouped based on their application in specific industries or technology divisions. This area represents overarching domains of expertise, critical for performing specialised tasks, solving complex problems and driving innovation in technical fields.	Developed by MIGHT and adapted from Industrial Skills Framework, 2022, Future Skills Framework, 2024 and Australia Skills Classification, 2021.
STEM skills	STEM skills belong to the group of technical skills based on the integration of the disciplines of science, mathematics, engineering and technology. They are a combination of the ability to produce scientific knowledge, supported by mathematical skills, in order to design and engineer technological and scientific products or services. The aim of STEM skills is to enhance people's competency in work and/or life and more generally respond to societal demands on technology.	Adapted from Siekmann, G & Korbel, P., 2016. Defining 'STEM' skills: review and synthesis of the literature – support document 2, NCVET, Adelaide.
Technology hierarchy structure	For technology hierarchy structure, the highest hierarchy is Division which represents the broadest subject area or discipline. Each Division has its own Category, Group and Area or Category and Group. The Categories, Groups and Areas at the lowest level represent more detailed dissections of the research disciplines.	Adapted from Ministry of Science, Technology and Innovation (MOSTI). (2021). Malaysian Research and Development Classification System MRDCS (7th Ed.). Putrajaya; Malaysia.
Technology prioritisation survey	A tool or process used to assess and rank various technologies based on their potential impact, feasibility and alignment with organisational or strategic goals. It helps decision-makers determine which technologies should be prioritised for development, investment, or adoption.	OECD. (2017). Policy Approaches to Research and Innovation. OECD Publishing. <a href="https://doi.org/10.1787/9789264267885-en">https://doi.org/10.1787/9789264267885-en</a>
Technology tool	A technology tool is a technology software and/or hardware that are utilised together with STEM skills to perform specialised tasks, solve complex problems and drive innovation in technical fields.	Developed by MIGHT and adapted from Australian Bureau of Statistics. (2024-version-1.0). OSCA - Occupation Standard Classification for Australia. ABS.
Time of Realisation	This refers to the full timeline required for a technology to go from concept or early development to practical implementation and mainstream availability. It includes all stages of R&D, testing, commercialisation and early adoption. The time of realisation varies depending on factors like technological complexity, regulatory hurdles and market readiness.	KISTEP (Korea Institute of S&T Evaluation and Planning). (2022). 6th Science and Technology Foresight (2021-2045). Seoul: KISTEP.

## APPENDIX B: LIST OF ABBREVIATIONS

<b>AI</b>	Artificial Intelligence	<b>LLMs</b>	Large Language Models
<b>AR</b>	Augmented Reality	<b>MaaS</b>	Machinery as a Service
<b>ASEAN</b>	Association of Southeast Asian Nations	<b>MQF</b>	Malaysian Qualifications Framework
<b>CCUS</b>	Carbon Capture, Utilisation and Storage	<b>mRNA</b>	Messenger Ribonucleic Acid
<b>CPD</b>	Continuing Professional Development	<b>MRDCS</b>	Malaysian Research and Development Classification System
<b>CREST</b>	Creativity in Research, Engineering, Science and Technology	<b>MRO</b>	Maintenance, Repair and Overhaul
<b>CSR</b>	Corporate Social Responsibility	<b>MSIC</b>	Malaysia Standard Industrial Classification
<b>CTO</b>	Chief Technology Officer	<b>MYSA</b>	Malaysian Space Agency
<b>DevOps</b>	Development Operations	<b>NEC</b>	National Education Code
<b>DOSH</b>	Department of Occupational Safety & Health	<b>NETR</b>	National Energy Transition Roadmap
<b>E&amp;E</b>	Electrical and Electronics	<b>NRF</b>	National Research Foundation
<b>ERI</b>	Education, Research and Innovation	<b>OECD</b>	Organisation for Economic Co-operation and Development
<b>ESG</b>	Environmental, Social and Governance	<b>PAJSK</b>	Pentaksiran Aktiviti Jasmani, Sukan dan Kokurikulum
<b>EV</b>	Electrical Vehicle	<b>PDM</b>	Predictive Maintenance
<b>eVTOL</b>	Electric Vertical Take-off and Landing Aircraft	<b>PTA</b>	Parent Teacher Association
<b>F.I.R.S.T.<sup>®</sup></b>	Funding and Financing, Infrastructure and Institution, Regulatory and Policy, Skills and Talents, and Technology and Innovation	<b>QA</b>	Quality Assurance
<b>FinTech</b>	Financial Technology	<b>QHSE</b>	Quality, Health, Safety and Environment
<b>FIRST</b>	For Inspiration and Recognition of Science and Technology	<b>R&amp;D</b>	Research and Development
<b>GDP</b>	Gross Domestic Product	<b>SBIR</b>	Small Business Innovation Research
<b>GLC</b>	Government-linked Company	<b>SMEs</b>	Small and Medium-sized Enterprises
<b>GLP</b>	Good Laboratory Practice	<b>SMRs</b>	Small Modular Reactors
<b>HAPS</b>	High-Altitude Platform Systems	<b>STEAM</b>	Science, Technology, Engineering, Arts and Mathematics
<b>ICT</b>	Information and Communication Technology	<b>STEM</b>	Science, Technology, Engineering and Mathematics
<b>IoT</b>	Internet of Things	<b>STI</b>	Science, Technology and Innovation
<b>IT</b>	Information Technology	<b>TVET</b>	Technical and Vocational Education and Training
<b>KISTEP</b>	Korea Institute of Science and Technology Evaluation and Planning	<b>UX</b>	User Experience
<b>KPI</b>	Key Performance Indicator	<b>VR</b>	Virtual Reality
<b>LCA</b>	Life Cycle Assessment		

# APPENDIX C: IDENTIFICATION OF NEW & EMERGING TECHNOLOGY CANDIDATES

The rapid growth of emerging technologies is transforming the future of STEM talent. As industries adopt these innovations, new specialised skills and roles are needed, changing both job markets and how organisations develop their workforce. In this context, new and emerging technologies are those still in development or recently introduced, which are in the early stages of adoption but gaining momentum due to their potential impact and application.

Recognising the importance of these technologies in shaping future skill demands a comprehensive horizon scanning was conducted. This process involved multiple layers of review and analysis to capture signals of technological change and assess their relevance to Malaysia's STEM ecosystem. The scanning drew from a variety of sources, including:

- National and international reports
- Benchmarking of countries' strategic technology focus areas
- Media and news scanning
- Scenario building
- Investment analysis
- National policy review
- Stakeholder engagements and
- Patent scanning

These diverse sources provided a well-rounded and evidence-based foundation for identifying technologies with high potential to influence Malaysia's future STEM ecosystem. Consequently, a total of 147 technology candidates were identified.

To systematically organise and classify these technologies, this study used the Malaysian Research and Development Classification System (MRDCS), 7th Edition, 2021, as the reference taxonomy. As shown in Figure C-1, the classification framework consists of three hierarchical levels:

- Division – representing the broadest subject area or discipline
- Category – a more specific domain within the Division and
- Technology Candidates – the actual technologies identified under each Category.

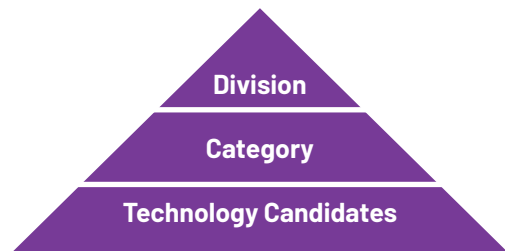


Figure C-1: Hierarchy structure for new and emerging technology candidate(s). Adapted from MRDCS (7th Edition), 2021.

Through this classification, the 147 technology candidates were grouped into six Divisions:

- Applied Sciences and Technology
- Earth Sciences
- Engineering
- Life Sciences
- Medical & Health Sciences and
- Social Sciences

Collectively, these six Divisions encompass 24 categories and 147 technology candidates.

## How to read this chart?

For instance, under the Division of Social Sciences, one of the identified Categories is Education, which includes the Technology Candidate Sensing Classroom. This demonstrates how the classification allows for a detailed yet structured understanding of emerging technologies and their relevance to specific domains.



Figure C-2: 147 new and emerging technology candidates.



## APPLIED SCIENCES AND TECHNOLOGY

### Bioinformatics

- DNA Data Storage
- Portable DNA Sequencer

### Biotechnology

- Alternative-protein Production
- Bioremediation
- Wastewater Bioplastic
- Genomic Vaccines
- Cell Therapy 2.0 (Innate Immune Cells, Precision Control of Cell Therapy, in Vivo Cell Therapy)
- Programmable Cells
- Cytotoxic Therapeutic
- Stabilised mRNA Therapeutics

### Food Technology

- Edible Packaging
- Active Packaging

### Geoinformation

- Geospatial Artificial Intelligence

### Geomatics

- Hyperspectral Imaging

### Material Sciences and Technology

- Self-Healing Materials
- Elastocalorics
- Solar Glass
- Biobased Materials
- Quantum Compass
- Circular Batteries
- Carbon-Cement Supercapacitor
- Solid State Lithium-Ion Battery
- Biosensor
- Metamaterials
- Mycological Biopolymers
- Graphyne
- Carbon Nanotube
- Advanced Composite Materials
- High Performance Thermoplastics
- Superhydrophobic Coatings
- Auxetic Material

### Medical Technology

- Health Monitoring Skin Patch
- Implantable Sensor
- Medical Nanobot
- Medical Tricorder
- Brain Chip Implant

### Information and Communication Technology (ICT)

- Generative AI
- Federated Machine Learning
- Responsible AI
- AI Mentor
- Machine Vision
- Edge Cloud Computing
- Neuromorphic Computing
- Quantum Computing
- Quantum Communication
- Quantum Key Distribution / Quantum Security
- Quantum Sensing
- Edge Computing
- Spatial Computing
- Predictive Maintenance
- Synthetic Data
- Metro edge / High Performance Data Storage and Data Centers
- Zero-trust Architecture
- Cybersecurity Mesh Infrastructure
- IoT Device Edge
- Wi-Fi 6 and 7
- 6th-Generation Wireless
- High-altitude Platform Systems
- Direct-to-handset Satellite Connectivity
- Industrial Internet of Things
- Mobility as a Service
- Low- and No-code Platforms
- Microservices and Application Programming Interfaces
- Blockchain of Things
- Web 3.0
- Middleware
- Proof-of-Stake Blockchain
- Augmented Reality
- Virtual Reality
- Mixed Reality
- Digital Twins
- AR Workforce Assistance
- Industrial Metaverse
- Cognitive Twin



## EARTH SCIENCES

### Environmental Sciences and Management

- Autonomous Sustainability Monitoring
- Carbon Dioxide Extractor Array



## SOCIAL SCIENCES

### Education

- Sensing Classroom
- Smart Classroom

Figure C-2: 147 new and emerging technology candidates.

### Technology Assessment on New and Emerging Technologies for Malaysia Towards 2040 and the STEM Skills Needed for Malaysian Talent

Building upon extensive desktop research and classification of 147 technology candidates, a survey was conducted to validate these findings and prioritise the technologies most likely to drive Malaysia’s economic growth through 2040. This survey also aimed to identify the STEM skill sets required to support the development, implementation and scaling of these technologies.

Each technology was evaluated based on its potential application, potential industries, time of realisation, required STEM skills and non-technical skills needed for development and deployment of this technology candidate.

The survey on new and emerging technologies engaged researchers, technology adopters and policymakers to ensure a comprehensive understanding of Malaysia’s future STEM talent needs:

- **Researchers** played a crucial role in identifying emerging trends and breakthrough technologies that may not yet be widely recognised, but which hold the potential to drive significant economic and societal advancements for Malaysia.
- **Technology adopters** played a critical role in providing insights into the alignment between talent development and sector-specific needs, helping to ensure that the future workforce is well-equipped to meet upcoming technological demands.
- **Policymakers** played an important role in shaping Malaysia’s strategic direction by contributing to the survey, ensuring the nation is prepared to address future challenges and capitalise on opportunities in technology and STEM talent development.
- **Investors** contributed by highlighting areas with strong potential for commercialisation and economic return, guiding the prioritisation of technologies that can attract funding and stimulate innovation-driven growth.

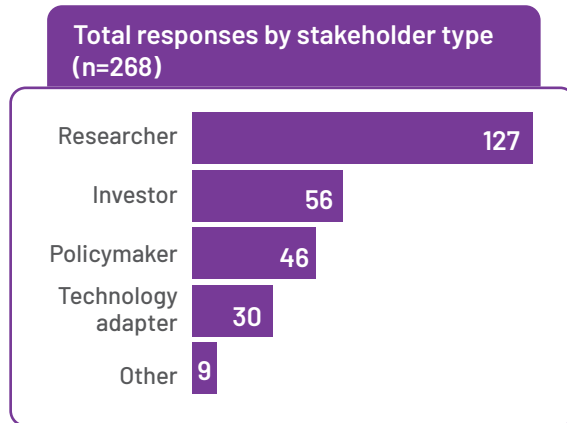


Figure C-3 Total responses by stakeholder type.

For the survey, a total of 268 responses were collected from 210 respondents, drawn from the 4,000 targeted participants across Malaysia. A total of 96 technology candidates has been assessed by the domain experts as shown in Figure C-4.

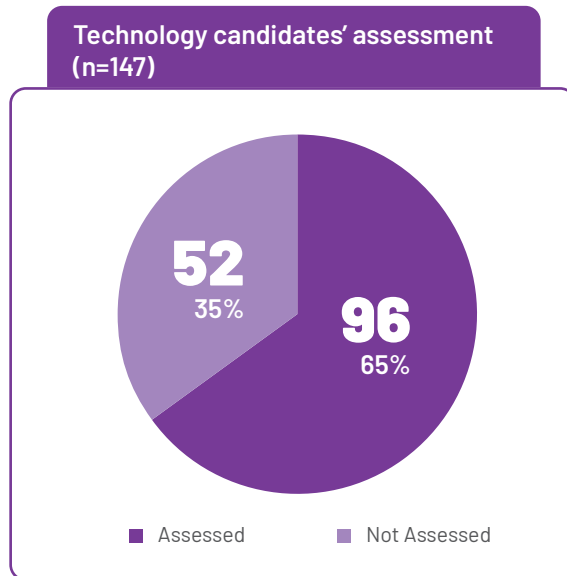


Figure C-4 Technology candidates’ assessment.

Most technologies assessed came from the Applied Sciences (39 assessed out of 75 total identified) and Engineering (39 out of 50), reflecting their strong alignment with Malaysia’s current industrial and technological development priorities.

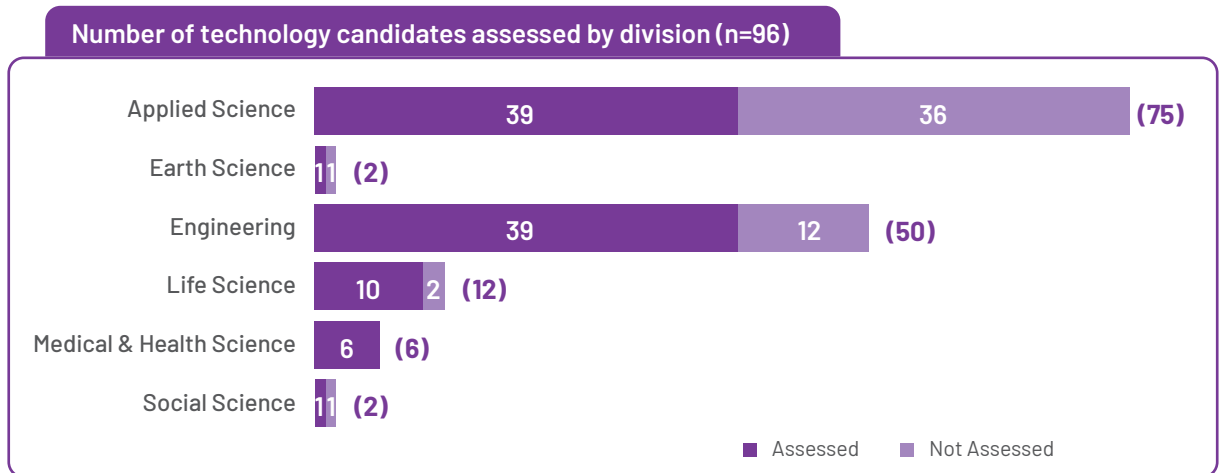


Figure C-5: Number of technology candidates assessed by technology division.

From the 96 assessed technology candidates, the survey identified the top ten most assessed technology candidates, with Smart Classroom receiving the highest number of assessments (19). This was followed by Generative AI and Telehealth & Remote Patient Monitoring, each with 13 assessments. Other technologies that ranked highly include Machinery as a Service (10), Advanced Urban Farming (8), Distributed Manufacturing (8), Precision Medicine (8) and Sustainable Fuels (8). Completing the list were Edible Packaging and the Industrial Internet of Things, each receiving 7 assessments. These technologies highlight priority areas among stakeholders in guiding Malaysia’s future STEM talent development.

### Technology Realisation Period: Local and Global Perspectives

New and emerging technologies progress through multiple stages, from early concept and research to testing, commercialisation and widespread adoption. The time required for this full trajectory, often referred to as the realisation period, can vary considerably depending on technological complexity, regulatory environments and market readiness (KISTEP, 2022). Understanding when these technologies are likely to become mainstream is critical to preparing the talent pipeline and aligning national strategies. This dual-layered analysis helps in identifying technologies that are rapidly advancing globally and those likely to be adopted more gradually within Malaysia due to differences in infrastructure, ecosystem maturity, or policy support.

The findings reveal that many technologies are anticipated to reach global maturity within the near term. Specifically, 77 technologies are expected to be globally realisable by 2030, with an additional 15 expected between 2031 and 2035 and three more by 2040. Notably, a further 15 technologies were included in the global list based on prior literature review and horizon scanning, even though they were not evaluated by respondents. In total, 110 technology candidates have been mapped with a global realisation period. Figure below visualises the distribution of global realisation periods.

### Global Realisation Period

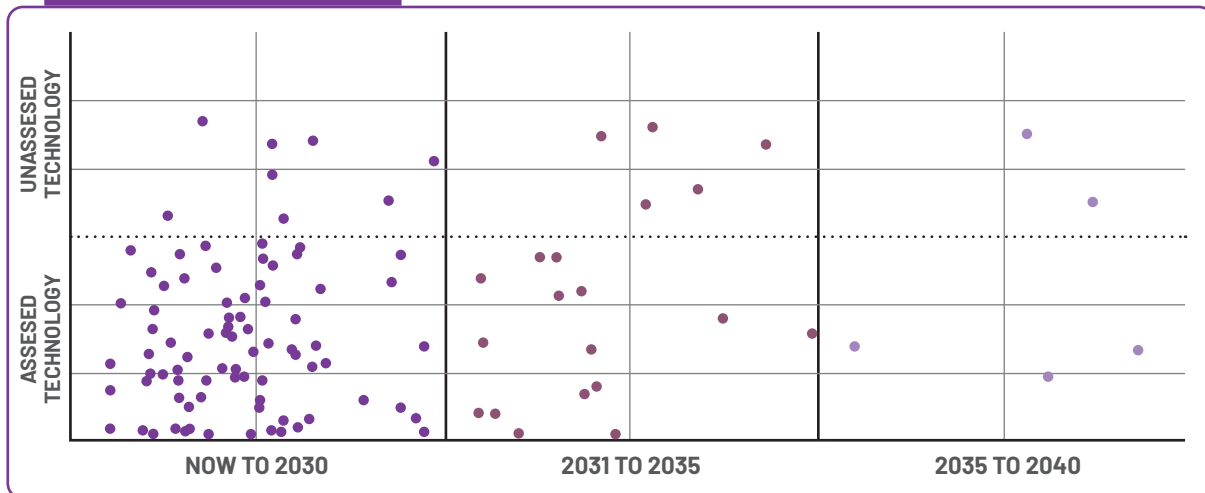


Figure C-6: Distribution of the technology candidates' global realisation periods

In comparison, the local realisation period presents a more staggered trajectory. Of the assessed technologies, 51 are projected to reach mainstream application in Malaysia by 2030, followed by 33 between 2031 and 2035 and 11 more between 2036 and 2040. While this indicates that most technologies could become locally relevant in the near term, it also reflects a noticeable delay in adoption relative to global timelines. This variation underscores the differing pace of technological integration across contexts. Figure below illustrates the distribution of local realisation periods.

### Local Realisation Period



Figure C-7: Distribution of the technology candidates' local realisation periods.

The analysis of global and local realisation periods offers valuable foresight into the maturity trajectories of new and emerging technologies. While most are anticipated to reach global maturity by 2030, Malaysia's adoption timelines are generally slower, highlighting critical gaps in ecosystem readiness. This delay underscores the urgency of aligning national strategies, infrastructure and policy to accelerate technology uptake. By understanding these timelines, Malaysia can better prioritise investments, tailor its STEM talent development efforts and position itself competitively in the global innovation landscape.

The tables below summarise the technologies by their respective global and local realisation periods:

Technology Candidate(s)	Global Realisation Period	Local Realisation Period
3D Printed Architecture	Now to 2030	Now to 2030
Active Packaging	Now to 2030	Now to 2030
Adaptive Processing of Recycled Materials	Now to 2030	2031 to 2035
Additive Manufacturing	2031 to 2035	Now to 2030
Adult Stem Cell Generation	Now to 2030	2031 to 2035
Advanced Alternative Animal Feed	Now to 2030	Now to 2030
Advanced Composite Materials	Now to 2030	Now to 2030
Advanced Urban Farming	Now to 2030	Now to 2030
Alternative-protein Production	Now to 2030	2036 to 2040
Anti-ageing Drugs	2031 to 2035	Now to 2030
Artificial Implantable Organs	Now to 2030	2031 to 2035
Autonomous Mobile Robots	Now to 2030	Now to 2030
Autonomous Sustainability Monitoring	Now to 2030	Now to 2030
Autonomous Unmanned Aerial Vehicles	2031 to 2035	2031 to 2035
Biobased Materials	Now to 2030	Now to 2030
Bioremediation	Now to 2030	Now to 2030
Biosensor	Now to 2030	Now to 2030
Biosimilar	Now to 2030	Now to 2030
Brain Chip Implant	2036 to 2040	2036 to 2040
Building Information Modelling	Now to 2030	Now to 2030
Carbon Capture, Utilisation and Storage	Now to 2030	Now to 2030
Carbon Nanotube	Now to 2030	2031 to 2035
Carbon-Cement Supercapacitor	Now to 2030	2036 to 2040
Cell Therapy 2.0	Now to 2030	2031 to 2035
Circular Batteries	Now to 2030	2031 to 2035
Clean Hydrogen	Now to 2030	Now to 2030
Cytotoxic Therapeutic	Now to 2030	2031 to 2035
Decentralised Energy Grid	Now to 2030	Now to 2030
Decentralised Wastewater Treatment	Now to 2030	Now to 2030
Digital Twins	Now to 2030	2031 to 2035
Direct Air Capture	2031 to 2035	2036 to 2040
Distributed Manufacturing	Now to 2030	Now to 2030
DNA Data Storage	Now to 2030	2031 to 2035
Drought-Resistant Crop	Now to 2030	Now to 2030
Edge Cloud Computing	2031 to 2035	2031 to 2035
Edible Packaging	Now to 2030	Now to 2030
Electric Vertical Takeoff and Landing Aircraft	2031 to 2035	2031 to 2035
Engineered Bacteriophage	Now to 2030	2036 to 2040
Engineered Livestock	Now to 2030	Now to 2030
Exoskeleton	Now to 2030	2031 to 2035
Generative AI and Agentic AI	Now to 2030	Now to 2030
Genomic Vaccines	Now to 2030	Now to 2030

Technology Candidate(s)	Global Realisation Period	Local Realisation Period
Geospatial Artificial Intelligence	Now to 2030	Now to 2030
Germplasm Bank	2031 to 2035	Now to 2030
Graphyne	2036 to 2040	Now to 2030
Green Cement	Now to 2030	Now to 2030
Green Steel	Now to 2030	2031 to 2035
Health Monitoring Skin Patch	Now to 2030	Now to 2030
High Performance Thermoplastics	Now to 2030	2031 to 2035
Humanoid General-Purpose Robot	2031 to 2035	2031 to 2035
Human-robot Collaboration	2031 to 2035	2031 to 2035
Hyperspectral Imaging	Now to 2030	2031 to 2035
Implantable Sensor	Now to 2030	2036 to 2040
Industrial 3D Printing	2031 to 2035	Now to 2030
Industrial Internet of Things	Now to 2030	Now to 2030
Integrated Autonomous Energy Grid	Now to 2030	2031 to 2035
IoT Device Edge	Now to 2030	2031 to 2035
Long Duration Energy Storage Systems	Now to 2030	Now to 2030
Low- and No-code Platforms	Now to 2030	Now to 2030
Low Earth Orbit Satellites	Now to 2030	2031 to 2035
Low-code / No-code Robot	Now to 2030	Now to 2030
Machine Learning-enabled Drug Discovery	Now to 2030	2031 to 2035
Machinery as a Service	Now to 2030	Now to 2030
Manufacturing Data Space	Now to 2030	Now to 2030
Medical Nanobot	Now to 2030	2031 to 2035
Microservices and Application Programming Interfaces	Now to 2030	2031 to 2035
Middleware	Now to 2030	Now to 2030
Neuromorphic Chip	2036 to 2040	2031 to 2035
Next-generation Gene Therapies	2031 to 2035	2036 to 2040
Ocean Wave Energy Technology	Now to 2030	Now to 2030
Onshore and Offshore Wind Turbines	Now to 2030	2031 to 2035
Optical Sensor Arrays	Now to 2030	Now to 2030
Orbital Launch Site	Now to 2030	2031 to 2035
Perovskite Solar Cell	2031 to 2035	2036 to 2040
Plant Biostimulants	Now to 2030	Now to 2030
Portable DNA Sequencer	Now to 2030	2036 to 2040
Precision Agriculture	Now to 2030	Now to 2030
Precision Medicine	Now to 2030	Now to 2030
Predictive Maintenance	Now to 2030	2031 to 2035
Quantum Computing	Now to 2030	2036 to 2040
Quantum Key Distribution / Quantum Security	Now to 2030	Now to 2030
Responsible AI	Now to 2030	2031 to 2035
Self-driving Bus	Now to 2030	2036 to 2040
Sewage Harvested Energy	2031 to 2035	Now to 2030
Small Modular Reactors	Now to 2030	2031 to 2035
Small Satellites	Now to 2030	Now to 2030

Technology Candidate(s)	Global Realisation Period	Local Realisation Period
Smart Classroom	Now to 2030	Now to 2030
Soft Robot	Now to 2030	2031 to 2035
Solar Glass	Now to 2030	Now to 2030
Stabilised mRNA Therapeutics	Now to 2030	2031 to 2035
Supercritical Fluid Technology	Now to 2030	Now to 2030
Sustainable Fuels	2031 to 2035	Now to 2030
Telehealth and Remote Patient Monitoring	Now to 2030	Now to 2030
Urban Irrigation	Now to 2030	Now to 2030
Virtual Reality	2031 to 2035	2031 to 2035
Wastewater Bioplastic	Now to 2030	Now to 2030
4D Printing	Now to 2030 <sup>1</sup>	Not Assessed
6th-Generation Wireless	Now to 2030 <sup>1</sup>	Not Assessed
AI Mentor	2031 to 2035 <sup>2</sup>	Not Assessed
Auxetic Material	Now to 2030 <sup>2</sup>	Not Assessed
Carbon Dioxide Extractor Array	2036 to 2040 <sup>2</sup>	Not Assessed
Chiplet	2031 to 2035 <sup>2</sup>	Not Assessed
Holographic 3D Printing	2031 to 2035 <sup>1</sup>	Not Assessed
Medical Tricorder	2031 to 2035 <sup>2</sup>	Not Assessed
Piezoelectric Nanogenerator	2031 to 2035 <sup>2</sup>	Not Assessed
Programmable Cells	2031 to 2035 <sup>1</sup>	Not Assessed
Quantum Communication	2031 to 2035 <sup>1</sup>	Not Assessed
Robot Caregiver	Now to 2030 <sup>1</sup>	Not Assessed
Robotic Swarm	2031 to 2035 <sup>2</sup>	Not Assessed
Sensing Classroom	Now to 2030 <sup>2</sup>	Not Assessed
Solid State Lithium-Ion Battery	2036 to 2040 <sup>2</sup>	Not Assessed

<sup>1</sup>KISTEP (Korea Institute of S&T Evaluation and Planning). (2022). *6th Science and Technology Foresight (2021-2045)*. Seoul: KISTEP.

<sup>2</sup>World Governments Summit. (2019). *Technology Radar*.

# APPENDIX D: LIST OF NEW AND EMERGING TECHNOLOGY CANDIDATES

## Division: Life Sciences

Category: Agriculture Sciences		
Technology Candidate	Description	Source
Advanced Alternative Animal Feed	In modern animal nutrition, an advanced alternative animal feed typically merges precision feeding ensuring optimal macro- and micronutrient intake with functional feed additives. This leads to enhanced feed efficiency, improved animal health and greater overall productivity	Food and Agriculture Organization of the United Nations. (2023). Alternative and advanced feeding practices to promote the responsible use of antimicrobials: Report of FAO Expert Meeting, FAO headquarters,
Advanced Urban Farming	Advanced urban farming grows food in cities using new methods. It saves space and helps the environment. Methods like vertical farming and hydroponics use smart tools like sensors and AI. These farms save water, use clean energy and recycle waste. They can be on rooftops or indoors. Though it can be expensive and hard to grow big, urban farming helps produce local food, reduce pollution and create jobs, making cities more sustainable.	Agrilog. (2024). Emerging Technologies in Agriculture: Innovations for the Future of Farming.
Drought-Resistant Crop	A genetically altered crop with a heightened tolerance to drought, which reduces the impact of dehydration on plant growth, allowing it to continue to produce when rainfall is limited. Thus, helping farmers in areas with inadequate water fall improve the yield of their crops.	Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH. (2019). tech detector.
Engineered Livestock	Engineered livestock are genetically modified animals using techniques like CRISPR, transgenesis and precision breeding. These methods improve traits such as disease resistance, growth and product quality, while also lowering farming's environmental impact. This approach supports food security, sustainable agriculture and the production of new biopharmaceuticals, highlighting the powerful role of genetic engineering in animal science.	Kwon, D. H., Gim, G. M., Yum, S. Y., & Jang, G. (2024). Current status and future of gene engineering in livestock. BMB reports, 57(1), 50-59.
Germplasm Bank	A germplasm bank serves as a critical repository for preserving the genetic diversity of plant and animal species. By storing seeds, tissues, or genetic material, these banks safeguard biodiversity, enable research and support breeding programs to enhance agricultural resilience. Germplasm banks play a pivotal role in ensuring food security and environmental sustainability amidst climate challenges.	World Governments Summit. (2019). Technology Radar.
Nano Silica Fertiliser	Nano silica is a special nanomaterial made from silicon with tiny pores that make it ideal for carrying helpful substances like biofertilisers and biopesticides in agriculture. Its porous structure boosts plant metabolism, increasing resistance, seedling growth, root development and photosynthesis. This helps farmers grow crops more efficiently and sustainably. Nano silica can also carry soil enhancers and nano sensors to analyse soil health.	Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH. (2019). tech detector.

### Category: Agriculture Sciences

Technology Candidate	Description	Source
Nanobiopesticides	Nanobiopesticides combine nanotechnology with biological materials to create more precise and sustainable pest control. They improve the delivery, stability and effectiveness of active ingredients, allowing for controlled release and longer-lasting protection. This reduces chemical use and helps combat pest resistance. While they offer a more eco-friendly and efficient approach to agriculture, large-scale use and regulation still pose challenges.	Hazafa, A., Murad, M., Umer Masood, M., Bilal, S., Nasir Khan, M., Farooq, Q., ... Naeem, M. (2022). Nano-Biopesticides as an Emerging Technology for Pest Management. IntechOpen. doi: 10.5772/intechopen.101285
Plant Biostimulants	Plant biostimulants contain substances and/or microorganisms whose function when applied to plants or the rhizosphere is to stimulate natural processes to improve nutrient uptake, nutrient use efficiency, tolerance to abiotic stress and crop quality. This hub focuses on nonmicrobial biostimulants.	Magnabosco, P., Masi, A., Shukla, R. et al. Advancing the impact of plant biostimulants to sustainable agriculture through nanotechnologies. Chem. Biol. Technol. Agric. 10, 117 (2023). <a href="https://doi.org/10.1186/s40538-023-00491-8">https://doi.org/10.1186/s40538-023-00491-8</a>
Precision Agriculture	Precision agriculture uses technology to make farming more efficient and sustainable. Tools like data analysis, sensors, satellite images and automation help farmers use water, fertiliser and pest control wisely. This reduces waste and harm to the environment. It works for small farms with apps and big farms with robots, helping farming produce more and handle climate change better.	Eccarelli, T., Chauhan, A., Rambaldi, G., Kumar, I., Cappello, C., Janssen, S., & McCampbell, M. (2022). Leveraging automation and digitalization for precision agriculture: Evidence from the case studies. Food and Agriculture Organization of the United Nations. <a href="https://doi.org/10.4060/cc2912en">https://doi.org/10.4060/cc2912en</a>

### Category: Biological Sciences

Technology Candidate	Description	Source
Engineered Bacteriophage	Bacteriophages, natural viruses known for their bacteria-eating properties, can be engineered using synthetic biology tools to create enhanced variants with unique attributes for prophylactic and therapeutic applications. Approaches such as high-throughput sequencing and genome editing can be employed to improve phage therapy efficacy and programmability.	Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH. (2019). tech detector.
Next-generation Gene Therapies	Researchers are advancing scalable methods for next-generation gene therapies that utilise RNA-based modalities, cutting-edge editing tools like CRISPR-Cas9 and novel nucleases to precisely target and rectify genetic defects. Non-nuclease editing and modulation methods enhance safety and efficiency, enabling therapies tailored to individual genetic profiles. These innovations open pathways to in vivo applications where edits occur directly in the body, offering transformative solutions for previously untreatable genetic diseases.	National Institutes of Health. (2023). Gene Editing – Digital Media Kit.
Sustainable Fuels	Sustainable fuels, including biomass-derived fuels, e-ammonia and e-methanol, are emerging as pivotal in reducing reliance on fossil fuels. Researchers are developing efficient methods to produce these fuels using renewable energy sources, enabling their application in various industries, including aviation through sustainable aviation fuels. These innovations are critical for meeting global climate targets while ensuring energy security.	IEA (2024), Towards Common Criteria for Sustainable Fuels, IEA, Paris. Retrieved from <a href="https://www.iea.org/reports/towards-common-criteria-for-sustainable-fuels">https://www.iea.org/reports/towards-common-criteria-for-sustainable-fuels</a> , Licence: CC BY 4.0

## Division: Medical and Health Sciences

Category: Pharmacy		
Technology Candidate	Description	Source
Adult Stem Cell Generation	Adult stem cells maintain tissue health and can replace cells that die due to injury or disease. Research suggests some adult stem cells could create various types of cells through a phenomenon known as transdifferentiation. If proved, it will open new frontiers in stem cell technologies.	Innovate UK. (2023). Welcome to the future Innovate UK's 50 Emerging Technologies.
Anti-ageing Drugs	'Geroprotective' drugs aim to affect the root cause of ageing and age-related diseases, lengthening the lifespan of animals. Approaches are being explored to selectively kill ageing, or 'senescent', cells or to suppress inflammation associated with ageing.	Innovate UK. (2023). Welcome to the future Innovate UK's 50 Emerging Technologies
Biosimilar	Biosimilars are medicines very similar to existing biologic drugs in safety, effectiveness and quality. Made after the original drug's patent ends, they use advanced biotech to match the original treatment. Biosimilars help make important medicines more affordable and accessible, especially for chronic diseases like cancer, diabetes and autoimmune conditions.	Malaysian Industry-Government Group for High Technology (MIGHT). (2023). Malaysian Technology Strategic Outlook 2023/2024: Space, Energy & Healthcare Sectors.
Machine Learning-Enabled Drug Discovery	Machine learning-enabled drug discovery uses AI to speed up finding and improving new medicines. Algorithms analyse large amounts of data, predict how drugs interact with targets and identify promising candidates quickly and accurately. This method cuts research time and costs while improving drug design, leading to new treatments for many diseases.	Aayush Gupta and Huan-Xiang Zhou
Precision Medicine	Precision medicine is a personalised healthcare approach that uses genetic, environmental and lifestyle information to improve diagnosis and treatment. It focuses on early disease detection and finding biomarkers to tailor therapies to each individual, reducing guesswork in treatment. This approach helps prevent disease and offers more effective care, while also improving public health strategies.	Malaysian Industry-Government Group for High Technology (MIGHT). (2023). Malaysian Technology Strategic Outlook 2023/2024: Space, Energy & Healthcare Sectors.

### Category: Specialist Topics in Medical and Health Sciences

Technology Candidate	Description	Source
Telehealth and Remote Patient Monitoring	Telehealth and remote patient monitoring use digital tools to provide healthcare and track patient health outside of clinics. They allow real-time video visits, manage chronic diseases and collect health data continuously through wearables and apps. These technologies improve access to care, lead to better health outcomes and ease pressure on healthcare systems by overcoming distance and other barriers.	Malaysian Industry-Government Group for High Technology (MIGHT). (2023). Malaysian Technology Strategic Outlook 2023/2024: Space, Energy & Healthcare Sectors.

### Division: Earth Sciences

#### Category: Environmental Sciences and Management

Technology Candidate	Description	Source
Autonomous Sustainability Monitoring	Automated Sustainability Monitoring uses sensors, satellite images, machine learning and AI to track sustainability data in real time. It helps businesses and governments manage energy, water, waste and emissions more effectively. Sensors placed across buildings, equipment, or fields collect data, which is sent to a central platform. There, AI analyses it and provides insights to improve environmental performance. These systems can work with or be part of manufacturing control centres and some include satellite imagery for a complete overview.	EIT Manufacturing. (2023). Tech Radar.
Carbon Dioxide Extractor Array	The carbon dioxide extractor array is an advanced system that captures CO <sub>2</sub> from the air on a large scale to help fight climate change. It uses chemical and physical methods like adsorption and membrane separation to remove and store carbon efficiently. When used in industries and energy systems, it helps reduce emissions and supports carbon-neutral goals. This technology plays a key role in carbon removal and climate action.	World Governments Summit. (2019). Technology Radar.

### Division: Engineering

#### Category: Aerospace, Aeronautics and Astronautics Engineering

Technology Candidate	Description	Source
Electric Vertical Take-off and Landing Aircraft	Electric vertical take-off and landing aircraft are electric vehicles that take off and land vertically, designed for efficient urban and regional air travel. Using advanced batteries and electric motors, they produce less noise, lower emissions and need less infrastructure than traditional planes. The technology aims to reduce traffic, improve connectivity and support sustainable, scalable air transportation.	Doo, J. T., Pavel, M. D., Didey, A., Hange, C., & Diller, N. P. (2021). NASA Electric Vertical Takeoff and Landing (eVTOL) Aircraft Technology for Public Services—A White Paper. NASA Technical Reports Server.
Low Earth Orbit satellites	Low earth orbit satellites fly at 500 to 2,000 kilometres above Earth, providing fast, low-latency connections ideal for communication, navigation and Earth observation. They support technologies like global internet and real-time monitoring, improving access to data worldwide. Low earth orbit satellite networks are transforming industries by offering reliable, scalable services at lower costs than traditional geostationary satellites.	Malaysian Industry-Government Group for High Technology (MIGHT). (2023). Malaysian Technology Strategic Outlook 2023/2024: Space, Energy & Healthcare Sectors.

### Category: Aerospace, Aeronautics and Astronautics Engineering

Technology Candidate	Description	Source
Orbital Launch Site	Orbital launch sites, including land-based spaceports and sea platforms, are facilities built to send payloads into orbit. They support missions like satellite launches and crewed space flights, using advanced infrastructure to ensure efficient launches. Sea-based platforms offer extra flexibility, especially for equatorial launches, which boost payload capacity and save energy. These launch sites are key to expanding access to space and supporting the growing space industry.	Boston Consulting Group. (2023). The growth of the space economy.
Small Satellites	Smallsats and Cubesats are small, lightweight satellites designed for affordable and flexible use in areas like Earth observation, communication and research. Made with modular parts, they are easy to launch and can support many types of missions, from climate tracking to IoT networks. These satellites are helping to open up space access, drive innovation and grow both commercial and scientific satellite services.	Malaysian Industry-Government Group for High Technology (MIGHT). (2023). Malaysian Technology Strategic Outlook 2023/2024: Space, Energy & Healthcare Sectors.

### Category: Biomedical Engineering

Technology Candidate	Description	Source
Artificial implantable organs	Artificial implantable organs are high-tech medical devices that mimic the function of real organs, helping patients with organ failure. Made with advanced materials and biocompatible technology, devices like artificial hearts, kidneys and lungs restore essential body functions. They reduce the need for donor organs, ease organ shortages and improve patients' quality of life, marking a major step forward in regenerative medicine and personalised care.	Malaysian Industry-Government Group for High Technology (MIGHT). (2023). Malaysian Technology Strategic Outlook 2023/2024: Space, Energy & Healthcare Sectors.

### Category: Chemical Engineering

Technology Candidate	Description	Source
Supercritical Fluid Technology	Supercritical fluid technology uses fluids at high temperature and pressure, above their critical point, where they act like both liquids and gases. In this state, the fluid can dissolve substances like a liquid and move through materials like a gas. SCF is used in processes like extraction, drug delivery and green chemistry. Carbon dioxide (CO <sub>2</sub> ) is the most common SCF because it's safe, effective and easy to control.	Clarivate. (2025). Derwent Innovations Index on Web of Science.  Clarivate. (2025). Innography IP Intelligence Software.

### Category: Civil Engineering

Technology Candidate	Description	Source
3D Printed Architecture	Three-dimensional printed architecture uses large 3D printers to build structures layer by layer from digital designs, often with concrete or recycled materials. This method, also called additive manufacturing in construction, helps address urban challenges like the need for affordable, sustainable housing by cutting labour costs, speeding up construction and reducing material waste.	Cappra Institute. (2024). Data Thinking Radar.
Building Information Modelling	Building Information Modelling creates and manages digital models of buildings and infrastructure, helping to unify construction and urban planning. These models provide accurate, shared information across all project stages from design to construction to operation. The technology improves efficiency, reduces errors, supports teamwork and promotes sustainable building practices.	Cappra Institute. (2024). Data Thinking Radar.
Urban Irrigation	Urban irrigation helps cities deal with heat, air pollution and flooding. It now goes beyond parks to include rooftops and roads. Using sprinklers, drip lines and smart tech like sensors and cloud systems, it uses water efficiently. Rooftop systems keep plants healthy, which cools buildings, while roadside irrigation reduces dust and cools streets. Moist soil also absorbs rain better, helping to prevent floods.	Cappra Institute. (2024). Data Thinking Radar.

### Category: Computer Engineering

Technology Candidate	Description	Source
4D Printing	4D printing is an evolution of 3D printing where materials are programmed to change shape or properties over time when exposed to external stimuli like heat, light, or moisture. It is used in fields such as healthcare, aerospace and smart textiles, enabling dynamic and adaptive products.	World Governments Summit. (2019). Technology Radar.
Additive Manufacturing	Additive manufacturing, or 3D printing, builds objects layer by layer from digital designs. It starts with a digital model, which is sliced into layers and materials like plastics, metals, or ceramics are added one layer at a time. This process supports fast prototyping, reduces waste, allows complex shapes and makes it easier to customise products.	EIT Manufacturing. (2023). Tech Radar.
Chiplet	Chiplet is a modular semiconductor design approach where smaller chips are combined into a single package to improve performance and flexibility. This innovation addresses the growing complexity of chip manufacturing, enabling scalable solutions for high-performance computing and AI applications.	World Governments Summit. (2019). Technology Radar.
Holographic 3D Printing	Holographic 3D printing uses light-based techniques to produce complex 3D structures with exceptional precision and speed. This technology is particularly impactful in creating medical devices, aerospace components and rapid prototyping with unparalleled accuracy.	World Governments Summit. (2019). Technology Radar.
Industrial 3D Printing	Industrial 3D printing involves large-scale additive manufacturing to produce durable, intricate components for sectors like aerospace, automotive and healthcare. It enhances efficiency, reduces material waste and enables customised production, revolutionising traditional manufacturing processes.	World Governments Summit. (2019). Technology Radar.
Neuromorphic Chip	Neuromorphic chip is a type of computer chip designed to mimic the neural structure and functioning of the human brain. These chips use artificial neurons to perform computations, aiming to replicate the brain's efficiency in processing information and learning from experiences.	World Governments Summit. (2019). Technology Radar.

### Category: Electrical and Electronic Engineering

Technology Candidate	Description	Source
On-body and Off-body Sensors	These sensors track data from the body or nearby environment. On-body sensors, like fitness trackers and health patches, are worn to measure things like heart rate, glucose levels, or activity. Off-body sensors work around the user to monitor air quality, temperature, or movement. Together, they support better health monitoring, personalised care and smarter living spaces.	M. Usman, M. R. Asghar, I. S. Ansari and M. Qaraqe, "Security in Wireless Body Area Networks: From In-Body to Off-Body Communications" in IEEE Access, vol. 6, pp. 58064-58074, 2018
Optical Sensor Arrays	Optical sensor arrays use light to detect and measure physical, chemical, or biological changes. They combine multiple sensors that monitor changes in light intensity, colour, or polarisation. Types include surface plasmon resonance, fluorescence, fibre optic and interferometric sensors. These arrays are used in environmental monitoring, healthcare and industry because they are highly sensitive, work in real time and can measure many things at once. They play a big role in precision medicine and smart sensing systems.	Clarivate. (2025). Derwent Innovations Index on Web of Science.  Clarivate. (2025). Innography IP Intelligence Software.

### Category: Energy Resources and Engineering

Technology Candidate	Description	Source
Clean Hydrogen	Clean hydrogen is hydrogen made using eco-friendly methods, like electrolysis powered by renewable energy (green hydrogen) or processes that capture carbon emissions (blue hydrogen). It serves as a versatile energy source and raw material with little or no greenhouse gas emissions. Clean hydrogen is important for reducing carbon in tough sectors like heavy industry, aviation and shipping and also helps with energy storage and balancing the power grid.	Yin, L. (2024). Clean as Water: a Hydrogen-Fueled Future. Harvard Technology Review.
Decentralised Energy Grid	A decentralised energy grid is a power system that works independently from a central grid. Unlike traditional factories that rely on a central grid making them vulnerable to outages and inefficiencies, the technology uses local energy sources like solar panels and wind turbines near the factory. This setup improves efficiency, cuts energy loss during transmission and boosts energy security for manufacturing plants.	EIT Manufacturing. (2023). Tech Radar.
Integrated Autonomous Energy Grid	The integrated autonomous energy grid is a smart energy system that automatically balances supply and demand in cities. It uses AI and machine learning to monitor and manage energy from renewables like solar and wind alongside traditional sources. By adjusting to changes in energy use and production, it ensures a steady, reliable supply while reducing waste and dependence on fossil fuels.	Cappra Institute. (2024). Data Thinking Radar.
Long Duration Energy Storage Systems	Long-duration energy storage systems supply energy for hours or days, helping manage renewable energy's ups and downs. They include: <ul style="list-style-type: none"> <li>• Mechanical storage, like pumped hydro and flywheels</li> <li>• Thermal storage, which saves heat or cold for later use</li> <li>• Electrochemical storage, such as lithium-ion and flow batteries</li> <li>• Chemical storage, using hydrogen and synthetic fuels</li> </ul> These systems improve energy reliability, balance the grid and support renewable energy use.	Stanford Emerging Technology Review. (2023). A report on ten key technologies and their policy implications. Stanford University.

## Category: Energy Resources and Engineering

Technology Candidate	Description	Source
Long-Range Wireless Energy Transmission	Energy can be transmitted safely and reliably over long distances using electromagnetic waves. The system uses a transmitting antenna, relay panels and a metamaterial antenna that converts the waves into direct current. Energy travels in focused long-wave beams between transmitters, preventing loss or stray radiation. Compared to expensive and complex cables, wireless transmission is more cost-effective and easier to maintain. It can power remote areas like islands, farms, communities, refugee camps and mobile hospitals and in the future, it could even send energy between Earth and space.	Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH. (2019). tech detector.
Ocean Wave Energy Technology	Ocean wave energy technology captures the power of ocean waves to produce electricity. It uses devices like buoys, floats, or underwater structures that convert the waves' up-and-down motion into electrical energy. These systems work mainly offshore where waves are strongest, using methods like floating point absorbers or oscillating water columns that use air pressure from waves. This renewable energy source can generate a lot of power with little environmental harm, helping reduce fossil fuel use and promote sustainable energy.	Clarivate. (2025). Derwent Innovations Index on Web of Science.  Clarivate. (2025). Innography IP Intelligence Software.
Onshore and Offshore Wind Turbines	Wind turbines generate electricity by capturing wind energy. Onshore turbines are placed on land and are cheaper and easier to install, making them common for land projects. Offshore turbines are in water, usually near coasts or open seas, where winds are stronger and steadier, so they produce more energy. However, they cost more to install and maintain because of tough marine conditions. Both types are essential for moving toward clean, renewable energy.	Foster, W., & Foster, W. (2024). The Future of wind Energy: Emerging trends and technologies. Energy Warden - Energy Warden.
Perovskite Solar Cell	Traditional silicon solar cells work well but can be expensive and don't get much better over time. Perovskite solar cells are a new kind of solar panel made from special crystals with lead or tin. In labs, they've shown they can be very efficient sometimes better than silicon. They are made by putting very thin layers on a surface using cheap methods, which makes them lighter and bendable. This makes them good for use in cities. These cells soak up sunlight, which makes tiny particles called electrons move and create electricity. A big plus is that they can catch more types of sunlight, even on cloudy days, so they work better in different weather.	Cappra Institute. (2024). Data Thinking Radar.
Piezoelectric Nanogenerator	The piezoelectric nanogenerator is a micro-energy harvester that converts mechanical energy, such as vibrations or movements, into electrical energy. It operates using piezoelectric materials, which generate electricity under mechanical stress. These devices are crucial in powering low-energy electronics like wearable devices, biomedical sensors and IoT nodes. Piezoelectric nanogenerators enable self-sufficient, battery-free systems, advancing sustainable energy solutions for portable and remote applications.	World Governments Summit. (2019). Technology Radar.
Sewage Harvested Energy	Sewage harvested energy technology transforms wastewater treatment facilities into energy sources by harnessing energy from organic matter in sewage. Through methods such as microbial fuel cells and anaerobic digestion, wastewater is converted into biogas or electricity. This approach not only reduces waste but also provides a sustainable energy source for urban areas and industrial facilities, making it a cornerstone of waste-to-energy initiatives.	World Governments Summit. (2019). Technology Radar.
Small Modular Reactors	Small modular reactors, or "mini nuclear reactors," provide clean and reliable energy that helps cut down fossil fuel use and pollution. They make electricity like big nuclear plants but are smaller and safer. Because of their size, this reactor can be used near factories or in remote places where energy is hard to get. They work by using a controlled nuclear reaction inside a small, sealed unit to make heat. This heat creates steam that turns turbines to produce electricity. It gives manufacturers easy access to efficient and safe energy close to their sites.	EIT Manufacturing. (2023). Tech Radar.

## Category: Environmental Engineering

Technology Candidate	Description	Source
Adaptive Processing of Recycled Materials	This innovation solves the challenge of maintaining consistent product quality when using recycled materials, which often have variable properties. Traditional manufacturing processes struggle with these fluctuations, leading to inconsistent results. Adaptive Processing overcomes this by using sensors, computer vision, real-time data analytics and artificial intelligence to assess the quality of incoming recycled materials. It then automatically adjusts key parameters like temperature, pressure and feed rates, ensuring the manufacturing process optimally adapts to the specific characteristics of the reclaimed materials.	EIT Manufacturing. (2023). Tech Radar.
Carbon Capture, Utilisation and Storage	Carbon Capture, Utilisation and Storage, also known as carbon capture and storage, addresses excess carbon dioxide emissions, a major contributor to environmental impact. This technology captures CO <sub>2</sub> from industrial processes like fossil fuel combustion or cement and steel production. It can also absorb CO <sub>2</sub> directly from the atmosphere using direct air capture systems. The captured CO <sub>2</sub> is then used in applications like enhanced oil recovery or converted into valuable byproducts, such as concrete. Additionally, the CO <sub>2</sub> can be safely stored underground, preventing it from re-entering the atmosphere and worsening climate change.	Malaysian Industry-Government Group for High Technology (MIGHT). (2023). Malaysian Technology Strategic Outlook 2023/2024: Space, Energy & Healthcare Sectors.
Decentralised Wastewater Treatment	Decentralised wastewater treatment systems treat wastewater close to its source, instead of relying on large sewer networks. These systems use technologies like membrane bioreactors, constructed wetlands and anaerobic digesters to efficiently clean wastewater. By processing pollutants and organic matter on-site, they produce treated water that can be safely released into the environment or reused for non-potable purposes like irrigation and industrial use.	Cappra Institute. (2024). Data Thinking Radar.
Direct Air Capture	Direct air capture is a technology that removes carbon dioxide directly from the air to help fight climate change. It uses chemical or physical processes, like solid sorbents or liquid solvents, to capture CO <sub>2</sub> , which can then be stored underground or reused in products like synthetic fuels, carbonated drinks, or building materials. The technology is a scalable solution that supports efforts to reduce emissions, aiming for net-zero or negative carbon emissions.	Lux research
Green Cement	Green cement is an eco-friendly alternative to traditional Portland cement, aimed at reducing the carbon footprint of cement production. Traditional cement manufacturing emits large amounts of CO <sub>2</sub> due to its reliance on fossil fuels and the calcination process. Green cement reduces these emissions by using alternative materials like fly ash, slag and silica fume, along with renewable energy and advanced technologies like carbon capture and alkali-activated binders. It plays a key role in sustainable construction, balancing environmental impact with strength and durability.	Lorea, C; Sanchez, F; Torres-Morales, E. 2024. Green Cement Technology Tracker, Version May 2024 (05/2024), Stockholm, Dataset
Green Steel	Green steel aims to solve the environmental issues of traditional steel production by reducing carbon emissions and resource use. It uses new methods like hydrogen-based reduction and carbon capture to cut emissions. Additionally, it replaces fossil fuels with cleaner energy, such as green hydrogen, which helps reduce greenhouse gases, save energy and lower dependence on non-renewable resources.	Lorea, C; Sanchez, F; Torres-Morales, E. 2024. Green Cement Technology Tracker, Version May 2024 (05/2024), Stockholm, Dataset

## Category: Interdisciplinary Engineering

Technology Candidate	Description	Source
Autonomous Mobile Robots	Autonomous mobile robots work independently inside factories or warehouses to transport materials and products. Unlike older Automated guided vehicles that had to follow fixed tracks, these robots use sensors, cameras and AI to understand their surroundings and navigate freely. They have detailed maps and can move accurately without needing special tracks or conveyors. These robots can carry items from one spot to another without human help and safely move around workers and machines without changing the factory setup.	EIT Manufacturing. (2023). Tech Radar.
Autonomous Unmanned Aerial Vehicles	Autonomous unmanned aerial vehicles are drones that fly and work by themselves using smart sensors, AI and navigation systems. They can be used for many tasks like surveillance, delivery, farming and disaster help. These drones are accurate, efficient and flexible. They help industries save money, gather better data and make quick decisions, creating new possibilities in many fields.	Gartner. (2024). The Gartner 2024 Hype Cycle for Emerging Technologies.
Biomimicry	Biomimicry, also called biomimetics, solves manufacturing problems by copying ideas from nature. It helps make products more sustainable, efficient and better designed. By learning from how nature works, we can save resources, use less energy and create less waste. For example, copying spider silk's strong but light structure can help make tougher and lighter materials for airplanes or safety equipment.	EIT Manufacturing. (2023). Tech Radar.
Exoskeleton	Exoskeletons, or exosuits, are used to improve worker safety and well-being, as they aid humans when doing heavy work or compensate for physical and motor deficiencies. Exoskeletons work by providing external support to the wearer, augmenting their strength, endurance and overall physical capabilities.	EIT Manufacturing. (2023). Tech Radar.
Graphene Cytobot	A nanoscale bio microrobot is made by covering a dormant bacterial spore with tiny particles called graphene quantum dots. This coating makes the spore electrically conductive and lets us control it remotely without changing its natural features. The robot uses the cell's tiny structures and machines to create responsive devices at the nano level. It can be controlled using magnetic systems and a precise electromechanical microscope stage.	Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH. (2019). tech detector.
Humanoid general-purpose robot	The humanoid general-purpose robot helps with problems like labour shortages and repetitive, hard tasks in manufacturing. These robots move like humans and can be programmed to do many jobs, such as putting together small parts, welding with precision and checking product quality. This helps lower production costs and makes products more consistent.	EIT Manufacturing. (2023). Tech Radar.
Human-robot Collaboration	Collaborative robots, or cobots, help factories meet the need for better precision, efficiency, flexibility and safety. Unlike traditional robots that work alone and can be risky, cobots work safely side-by-side with people. They use smart technology like sensors and AI to adjust to their surroundings and work together with humans, making the workplace safer and more efficient.	EIT Manufacturing. (2023). Tech Radar.
Low-code/No-code Robot	The low-code/no-code robot uses easy software that doesn't need complicated programming, so anyone can use it even without tech skills. It works with simple tools like touchscreens and user-friendly designs to help robots and people work together smoothly. Some newer robots can even learn by copying how humans do tasks.	EIT Manufacturing. (2023). Tech Radar.
Robot Caregiver	These robots use machine learning and vision to help elderly people and those with disabilities in their daily lives. They learn and adapt to each person's needs by understanding gestures, speech and body language. Using this technology, the robots can recognise how people move and feel, so they can offer personalised help and suggest activities that fit each person better.	Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH. (2019). tech detector.

### Category: Interdisciplinary Engineering

Technology Candidate	Description	Source
Robotic Swarm	Robotic swarm technology uses many small, smart robots that work together to complete difficult tasks. Inspired by how animals like bees and ants work as a group, these robots talk to each other and coordinate using smart programs. They are useful in areas like search and rescue, farming and manufacturing, where teamwork helps them do jobs better than one robot alone. This technology makes operations more efficient, flexible and strong in changing situations.	World Governments Summit. (2019). Technology Radar.
Self-Driving Bus	Self-driving buses, also called autonomous shuttles, use smart technology like AI, sensors and machine learning to drive without a human driver. They have tools like LiDAR, radar, cameras and GPS to help them move safely through busy city streets. These buses constantly gather and understand information around them to make quick decisions, like slowing down, avoiding obstacles and following traffic rules, so passengers have a smooth and safe ride.	Cappra Institute. (2024). Data Thinking Radar.
Soft Robot	Soft robots are flexible machines made from bendable materials that imitate living things. They are great at moving through delicate spaces and doing jobs like medical tasks, search-and-rescue, or flexible manufacturing. Because they can change shape and adapt, they're perfect for work that needs careful precision and flexibility.	World Governments Summit. (2019). Technology Radar.

### Category: Manufacturing and Industrial Engineering

Technology Candidate	Description	Source
Antimicrobial Packaging	Antimicrobial packaging integrates active agents into materials to inhibit the growth of bacteria, fungi and other harmful microorganisms, extending the shelf life of food, pharmaceuticals and other perishables. Using advanced coatings, nanotechnology and biodegradable polymers, it ensures safety, reduces waste and addresses contamination risks. This innovative packaging is pivotal in maintaining supply chain integrity while enhancing consumer health and sustainability.	ITONICS Innovation. (2024). Technology Radar.
Distributed Manufacturing	Distributed manufacturing fixes problems like high shipping costs, long wait times and few options for customising products. It uses smart tech like the Internet of Things, cloud computing, AI and sometimes 3D printing to set up smaller factories closer to customers. This means products get made nearby, so shipping costs and pollution go down. It also lets companies make things faster and with more choices for customers. It helps the environment and lets small local businesses sell to more people, which helps the economy grow.	EIT Manufacturing. (2023). Tech Radar.
Machinery as a Service	Machinery as a service lets companies rent machines instead of buying them, so they don't have to pay a lot of money upfront or for repairs. They only pay for what they use, usually with a subscription or pay-as-you-go plan. The machines have sensors that send data, so companies can watch and control them online from anywhere. This makes it easier for smaller companies to use smart, energy-saving machines without owning them. This technology also helps companies change what they do quickly and supports cleaner, greener manufacturing.	EIT Manufacturing. (2023). Tech Radar.
Manufacturing Data Space	Manufacturing data spaces create a secure, shared platform where manufacturers collect and organise data from sensors, machines and production lines. This enables easy data sharing across the supply chain and better collaboration. By providing tools for analysis, it helps predict equipment issues, improve quality and optimise processes leading to greater efficiency, less downtime and cost savings. This approach supports faster decision-making, drives innovation and helps manufacturers adapt to changing markets, making it vital for the future of manufacturing.	EIT Manufacturing. (2023). Tech Radar.

## Category: Material Sciences and Technology

Technology Candidate	Description	Source
Advanced Composite Materials	Advanced composite materials combine high-strength fibres, such as carbon or glass, with lightweight matrices to deliver exceptional mechanical properties. Renowned for their durability, stiffness and resistance to environmental factors, these materials are used in aerospace, automotive and renewable energy applications. Advanced composites enable weight reduction, energy efficiency and enhanced performance, driving innovation in high-performance engineering and sustainable design.	ITONICS Innovation. (2024). Technology Radar.
Auxetic Material	Auxetic materials expand laterally when stretched, unlike conventional materials. Their unique mechanical properties make them suitable for protective equipment, biomedical devices and aerospace applications, offering superior performance under stress.	World Governments Summit. (2019). Technology Radar.
Biobased Materials	Bio-sourced materials, or biobased materials, are derived from renewable resources like plants, agricultural products and waste. They address sustainability and resource scarcity by converting biological sources into materials like bioplastics, biofuels, textiles and building materials. Examples include extracting cellulose, starch, or oils from plants, fermenting microorganisms to produce compounds and growing mycelium as a leather alternative. These materials offer eco-friendly solutions across various industries.	EIT Manufacturing. (2023). Tech Radar.
Biosensor	Smart sensor technology involves sensors that detect and measure physical phenomena (like temperature, motion, or light) and process data in real-time, often triggering actions based on that data. Integrated with communication capabilities, these sensors send information to networks for analysis and automation, enabling smarter decision-making. Used in applications like smart homes, industrial automation and healthcare, smart sensors are key to the Internet of Things (IoT), helping optimise processes, improve efficiency and reduce human intervention.	Swiss Department of Defense. (2019). The Future of Supply Chain.
Carbon-Cement Supercapacitor	Carbon-cement supercapacitors are an ingenious blend of cement, water and carbon black. When combined, these materials create a supercapacitor with a high internal surface area, allowing for significant energy storage capacity. The process involves the water forming a network of branching openings within the cement as it cures, with carbon black migrating into these spaces to form conductive structures. Once soaked in an electrolyte, these structures enable the material to function as a supercapacitor, storing and discharging energy efficiently.	Cappra Institute. (2024). Data Thinking Radar.
Circular Batteries	Circular batteries are designed for sustainability, emphasising reuse, refurbishment and recycling throughout their lifecycle. Unlike traditional batteries that are discarded, these are built for easy disassembly and component recovery, reducing reliance on virgin materials and minimising environmental impact. This approach extends battery lifespan through second-life applications and efficient recycling, supporting a more sustainable energy system.	Cappra Institute. (2024). Data Thinking Radar.
Carbon Nanotube	Carbon nanotubes are cylindrical nanostructures known for their exceptional strength, electrical conductivity and thermal properties. They are widely applied in electronics, advanced materials and energy storage systems, driving innovation in multiple industries.	World Governments Summit. (2019). Technology Radar.
Elastocalorics	Traditional cooling systems are energy-hungry and contribute to greenhouse gas emissions. Elastocalorics offer a cleaner, energy-efficient alternative by using materials that change temperature under mechanical stress to absorb or release heat. Unlike systems with harmful refrigerants, elastocaloric technology relies on solid materials, making it safer and more environmentally friendly.	Cappra Institute. (2024). Data Thinking Radar.

## Category: Material Sciences and Technology

Technology Candidate	Description	Source
Graphyne	Graphyne is a carbon-based material with a unique lattice structure, offering properties similar to graphene but with enhanced flexibility and tuneable electronic characteristics. It has potential applications in advanced electronics, nanotechnology and energy storage.	World Governments Summit. (2019). Technology Radar.
High Performance Thermoplastics	High-performance thermoplastics are a class of polymers engineered to withstand extreme temperatures, chemicals and mechanical stress while maintaining lightweight and flexible characteristics. Used in industries like aerospace, healthcare and electronics, these materials enhance product longevity and reliability. Their recyclability and adaptability make high-performance thermoplastics integral to sustainable manufacturing and advanced material science.	ITONICS Innovation. (2024). Technology Radar.
Superhydrophobic Coatings	Superhydrophobic coatings are surface treatments that repel water and reduce friction by creating ultra-water-resistant surfaces with nanoscale structures. These coatings prevent corrosion, fouling and icing while enhancing self-cleaning properties, making them valuable in sectors ranging from electronics to aviation. Superhydrophobic technologies optimise efficiency and durability, offering transformative solutions for a range of industrial and consumer applications.	ITONICS Innovation. (2024). Technology Radar.
Metamaterials	Metamaterials can be formed from traditional materials that are easy to find in any natural environment. They are engineered structures designed to interact with electromagnetic radiation. These structures are very small, usually smaller than the wavelength of the radiation they are interacting with. These so-called meta-atoms can interact with the electric and magnetic components of light in a way that natural atoms do not, giving metamaterials unusual properties.	Innovate UK. (2023). Welcome to the UK's 50 Emerging Technologies.
Mycological Biopolymers	Mycological biopolymers use fungi, mainly mycelium, the root-like part of fungi, to produce sustainable, biodegradable materials. Growing in controlled environments, mycelium forms natural polymers that can be shaped into foams, packaging, textiles and more. These materials offer a renewable, eco-friendly alternative to plastics and synthetics, with uses in packaging, construction, fashion and agriculture. Mycological biopolymers support sustainable manufacturing and help reduce environmental impact by replacing non-biodegradable products.	Clarivate. (2025). Derwent Innovations Index on Web of Science.  Clarivate. (2025). Innography IP Intelligence Software.
Quantum Compass	The quantum compass, also known as a quantum gyroscope or inertial navigation system, leverages quantum mechanics to detect motion with exceptional precision. It measures small changes in atomic states caused by movement to determine orientation and position without relying on external signals like GPS. Unlike GPS, which can be disrupted, the quantum compass operates independently, making it ideal for environments like tunnels, dense cities, or underwater. It uses cold atoms or quantum particles that react sensitively to motion, translating these reactions into highly accurate navigation data, offering a reliable solution when GPS is unavailable.	Cappra Institute. (2024). Data Thinking Radar.
Self-Healing Materials	Self-healing materials are specially designed substances that can repair damage on their own, without human help. They offer a smart solution to the costly and time-consuming problem of maintaining infrastructure like roads, bridges and buildings in urban areas. These materials work by automatically reacting when damage occurs. For example, self-healing concrete may contain tiny capsules filled with a repair agent. When cracks appear, the capsules break and release the agent, which seals the cracks. Other materials use systems similar to blood vessels to deliver healing substances to the damaged area.	Cappra Institute. (2024). Data Thinking Radar.

### Category: Material Sciences and Technology

Technology Candidate	Description	Source
Solar Glass	Solar glass, also known as photovoltaic windows or solar windows, are advanced building materials that incorporate thin layers of photovoltaic cells within the windowpanes. These cells convert sunlight into electricity, providing a dual function of allowing natural light to enter buildings while simultaneously generating renewable energy. The technology works through the integration of transparent solar cells, which can be embedded within the glass or applied as a coating. These cells capture sunlight and convert it into electrical energy, which can be used to power the building or fed back into the grid.	Cappra Institute. (2024). Data Thinking Radar.
Solid State Lithium-Ion Battery	Solid-state lithium-ion batteries are an advanced type of battery that use solid materials instead of liquid electrolytes. This key change improves safety, energy density and battery life. They charge faster, last longer and store more energy than traditional lithium-ion batteries, making them ideal for electric vehicles, renewable energy systems and portable devices. Because they're more stable and efficient, solid-state batteries are expected to play a major role in the future of clean energy and electric mobility.	World Governments Summit. (2019). Technology Radar.

### Division: Applied Sciences and Technology

#### Category: Bioinformatics

Technology Candidate	Description	Source
DNA Data Storage	DNA data storage encodes digital data into synthetic DNA strands, offering far greater storage density and durability than traditional media like hard drives. It drastically reduces physical space and energy use 33 zettabytes of data could fit in less than the size of a ping-pong ball, making it a promising solution for future data demands.	Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH. (2019). tech detector.
Portable DNA Sequencer	A portable DNA sequencer is a compact device that allows on-site analysis of genetic material, enabling rapid and accessible genomic insights. This technology is widely used in healthcare, forensic science, agriculture and biodiversity studies, empowering researchers and professionals with real-time data for decision-making.	World Governments Summit. (2019). Technology Radar.

#### Category: Biotechnology

Technology Candidate	Description	Source
Alternative-protein Production	Alternative-protein production, including cultivated meats, involves innovative techniques such as cell cultivation and fermentation to produce protein-rich foods without traditional livestock farming. This technology addresses environmental concerns, animal welfare and global food security, offering sustainable, scalable protein alternatives. Cultivated meats represent a revolution in food science, promising reduced greenhouse gas emissions and resource use compared to conventional meat production.	Samad, A., Kim, S. ... Joo, S. (2024). Revolutionizing cell-based protein: Innovations, market dynamics and future prospects in the cultivated meat industry. Journal of Agriculture and Food Research, 18, 101345.
Bioremediation	Bioremediation technology uses microorganisms to reduce, eliminate, contain or transform contaminants present in the soil, water and air. The growth of naturally occurring microbes could encourage or augmented, or the system could rely on a combination of natural and engineered microorganisms.	Swiss Department of Defense. (2019). The Future of Supply Chain.

## Category: Biotechnology

Technology Candidate	Description	Source
Cell therapy 2.0	Cell therapy 2.0 introduces advanced techniques to harness innate immune cells, precision-engineer cell behaviours and deliver therapies directly in vivo. These innovations improve therapeutic efficacy, reduce side effects and expand the scope of cell-based treatments for cancer, autoimmune diseases and regenerative medicine. By integrating precise control and novel delivery methods, Cell Therapy 2.0 enhances the potential of cellular interventions for personalised healthcare.	Bashor, C.J., Hilton, I.B., Bandukwala, H. et al. Engineering the next generation of cell-based therapeutics. <i>Nat Rev Drug Discov</i> 21, 655–675 (2022).
Cytotoxic Therapeutic	Cytotoxic therapeutic technology uses substances that specifically kill harmful cells, especially cancer cells, by damaging their DNA or disrupting cell division. Delivered via chemotherapy, targeted therapies, or antibody-drug conjugates, these treatments are key in fighting tumours but can also affect healthy cells, so side effects must be managed carefully.	Clarivate. (2025). Derwent Innovations Index on Web of Science.  Clarivate. (2025). Innography IP Intelligence Software.
Genomic Vaccines	Genomic vaccines use engineered RNA or DNA sequences to instruct cells to produce specific antigens, triggering a targeted immune response. This platform enables rapid development, adaptability to emerging pathogens and scalable manufacturing. Exemplified by mRNA-based COVID-19 vaccines, genomic vaccines are transforming infectious disease prevention and therapeutic interventions, heralding a new era in precision medicine.	Malaysian Industry-Government Group for High Technology (MIGHT). (2023). Malaysian Technology Strategic Outlook 2023/2024: Space, Energy & Healthcare Sectors.
Programmable Cells	Programmable cells are bio-engineered cells designed to perform specific tasks by integrating chemical switches into their genetic circuits. These switches allow the cells to sense their environment, make decisions and execute actions based on pre-defined logical functions. This innovative technology leverages synthetic biology to create living cells that can carry out complex functions autonomously.	Innovate UK. (2023). Welcome to the UK's 50 Emerging Technologies.
Stabilised mRNA Therapeutics	Stabilised mRNA therapeutics improve the durability and effectiveness of mRNA treatments by using chemical modifications and delivery systems that prevent degradation and boost protein production in cells. Methods like codon optimisation, cap structure changes and lipid nanoparticle delivery help ensure the mRNA reaches target cells and works efficiently. This approach has enabled rapid advances in vaccines (like COVID-19), cancer therapies and gene treatments, offering faster, scalable and personalised medical solutions.	Clarivate. (2025). Derwent Innovations Index on Web of Science.  Clarivate. (2025). Innography IP Intelligence Software.
Wastewater Bioplastic	Wastewater bioplastic is a biodegradable plastic made from organic waste in wastewater. Microbes feed on methane and other byproducts from wastewater treatment, while yeast helps convert them into longer-chain PHAs (bioplastics). Using organisms like <i>Cryptococcus curvatus</i> and <i>Pseudomonas putida</i> , this plastic is eco-friendly, naturally breaks down, captures greenhouse gases during production and turns waste into a valuable product, supporting a circular economy.	Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH. (2019). tech detector.

### Category: Food Technology

Technology Candidate	Description	Source
Active Packaging	Active packaging integrates advanced materials and technologies into traditional packaging to interact with the contents or environment. By including features like oxygen scavengers, antimicrobial agents, or freshness indicators, it prolongs shelf life and ensures product safety. Widely used in the food, pharmaceutical and consumer goods industries, active packaging addresses the need for smarter, more responsive packaging solutions in global supply chains.	World Governments Summit. (2019). Technology Radar.
Edible Packaging	Edible packaging uses biodegradable, food-safe materials like seaweed, starch, or proteins to create packaging that can be eaten or safely decomposed. This innovation provides a sustainable alternative to plastic, reduces waste and environmental pollution and meets the increasing consumer demand for eco-friendly products. Widely applicable in the food and beverage industries, edible packaging supports a circular economy by minimising packaging waste.	World Governments Summit. (2019). Technology Radar.

### Category: Geoinformation

Technology Candidate	Description	Source
Geospatial Artificial Intelligence	Geospatial artificial intelligence combines AI with geographic data to analyse spatial patterns, optimise resource management and inform decision-making. Used in urban planning, disaster response and environmental monitoring, the technology enhances precision and scalability in geospatial analytics. This technology transforms how organisations understand and interact with complex spatial systems, driving innovation in fields like agriculture, transportation and public health.	EIT Manufacturing. (2023). Tech Radar.

### Category: Geomatics

Technology Candidate	Description	Source
Hyperspectral Imaging	Hyperspectral imaging is an advanced remote sensing technology that helps manage urban resources and infrastructure more efficiently. Unlike regular cameras that see only red, green and blue, the technology captures hundreds of narrow light bands, giving detailed information about materials and conditions. This technology allows cities to detect air pollutants, identify building materials and monitor plant health in parks with high precision. By providing more accurate and timely data than traditional methods, the hyperspectral imaging improves decision-making in areas like environmental monitoring, infrastructure maintenance and public safety.	Innovate UK. (2023). Welcome to the UK's 50 Emerging Technologies.

## Category: Information and Communication Technology

Technology Candidate	Description	Source
6th-Generation Wireless	The 6th-generation wireless technology, or the next frontier in wireless communication, is poised to revolutionise the manufacturing industry. 6G operates by harnessing the terahertz frequency band, providing data transfer speeds and latency reductions beyond what 5G can achieve. This is accomplished through advanced technologies like photonic communication, AI-driven network optimisation and the integration of satellite communication.	EIT Manufacturing. (2023). Tech Radar.
AI Mentor	AI mentors are intelligent systems designed to guide and support users in personal or professional development. By leveraging machine learning and natural language processing, they offer tailored advice, personalised learning experiences and continuous feedback, transforming education, career coaching and self-improvement.	World Governments Summit. (2019). Technology Radar.
Augmented Reality Workforce Assistance	Augmented reality workforce assistance enhances problem-solving on the shop floor by blending the physical world with a digital layer of information. It addresses challenges in tasks like assembly, maintenance and training by overlaying crucial data onto the real world via AR-enabled devices, such as smart glasses. Depending on the manufacturer's needs, ARWA can display text, images, or 3D visuals and even control physical IoT-enabled machines or structures through virtual interactions.	EIT Manufacturing. (2023). Tech Radar.
Augmented reality	Augmented reality overlays digital content, like images or sounds, onto the real world through devices like smartphones, tablets, or augmented reality glasses. By enhancing the physical environment with virtual elements, augmented reality creates immersive experiences in fields like gaming, education, retail and healthcare. It bridges the gap between the digital and physical worlds, offering interactive and contextually relevant information in real time.	Swiss Department of Defense. (2019). The Future of Supply Chain.
Blockchain of Things	The convergence of the Internet of Things and Blockchain ensures data integrity and security in IoT applications by creating decentralised, tamper-proof systems. The Blockchain of Things integrates IoT devices with blockchain networks, recording data in a transparent and immutable ledger. For manufacturers, this ensures reliable, authentic data exchange between devices and facilities, reducing the risk of data manipulation and unauthorised access. For customers, it enhances supply chain transparency, guaranteeing product authenticity and promoting fair trade practices.	EIT Manufacturing. (2023). Tech Radar.
Cognitive Twin	The cognitive twin is an advanced version of the digital twin, offering real-time digital replicas of manufacturing systems like factory floors or production lines, enhanced with cognitive abilities. It incorporates memory, perception and attention to improve precision, efficiency and adaptability in operations. By leveraging cognitive design, it allows systems to store, process and understand data contextually, enabling smarter decision-making and real-time adjustments in manufacturing processes.	EIT Manufacturing. (2023). Tech Radar.
Cybersecurity Mesh Infrastructure	Cybersecurity mesh infrastructure is a modern cybersecurity approach that enables distributed enterprises to secure decentralised assets, like hybrid and multi-cloud environments. It integrates solutions such as firewalls and cloud-based security services to address the growing network vulnerabilities from remote work and cloud migration. As cybercrime costs surge to USD 6 trillion annually, cybersecurity mesh offers fast deployment and seamless collaboration between security tools, enhancing overall protection.	Gartner. (2024). The Gartner 2024 Hype Cycle for Emerging Technologies [Webinar].
Digital Twins	A digital twin is a virtual replica used to optimise product lifecycles and simulate real-world performance. The create-build-sustain approach enables continuous product or service optimisation even after its physical counterpart is built. Enabled by Machine Learning and IoT, Digital Twins are reducing costs and improving efficiency across industries. However, their effectiveness requires the digital replica to be integrated throughout the entire value chain.	Swiss Department of Defense. (2019). The Future of Supply Chain.

## Category: Information and Communication Technology

Technology Candidate	Description	Source
Direct-to-handset Satellite Connectivity	Direct-to-handset satellite connectivity allows satellite networks to provide cellular and broadband services directly to standard mobile devices without requiring specialised hardware. It leverages advancements in low Earth orbit satellite constellations to deliver seamless connectivity in areas lacking terrestrial infrastructure, such as rural regions, oceans, or disaster zones. This technology bridges the digital divide, enabling uninterrupted communication and internet access for underserved populations.	McKinsey & Company. (2024, August 10). Technology trends outlook 2024.
Edge Cloud Computing	Edge cloud computing decentralises data processing by moving computation and storage closer to the data source, reducing latency and enhancing real-time performance. This hybrid model combines the scalability of cloud resources with the speed and efficiency of edge networks. Edge cloud computing is essential for powering latency-sensitive applications such as autonomous vehicles, smart cities and industrial IoT, delivering faster and more resilient systems.	McKinsey & Company. (2024, August 10). Technology trends outlook 2024.
Edge Computing	Edge computing addresses the challenge of data latency and bandwidth limitations in traditional centralised cloud-based systems, which rely on distant data centres. This solution involves processing data as close as possible to its source, usually at the "edge" of the network, through localised devices and servers. Doing so significantly reduces the time it takes for data to travel to the cloud and back, solving the critical issues of real-time decision-making and reducing network congestion.	EIT Manufacturing. (2023). Tech Radar.
Federated Machine Learning	Federated machine learning is a decentralised approach to training AI models where data remains localised on devices or servers and only model updates are shared. This ensures data privacy and reduces transmission costs while enabling collaborative learning across distributed datasets. Federated learning is critical in domains like healthcare and IoT, where data sensitivity and real-time processing are paramount, offering scalable and secure AI solutions.	Gartner. (2024). The Gartner 2024 Hype Cycle for Emerging Technologies [Webinar].
Generative Artificial Intelligence and Agentic Artificial Intelligence	Generative artificial intelligence and agentic artificial intelligence combines content creation with autonomous decision-making. Early generative systems focused on creating new outputs from text and images to 3D designs through data generation and translation such as turning sketches into photorealistic renders or datasets into natural-language insights. With the addition of advanced reasoning capabilities these systems have evolved into agentic AI that not only generating content but also setting goals, planning, making decisions and acting independently based on what they create. This shift allows AI to move from simply producing ideas to executing tasks in real-world settings such as manufacturing, healthcare, robotics and mobility.	Munich Re/ ERGO Business Technology. (2025). Tech Trend Radar 2025.
High-altitude Platform Systems	High-altitude platform systems are aerial vehicles, such as balloons or drones, operating in the stratosphere (20–50 km above sea level). They provide cost-effective communication, surveillance and monitoring over large areas, especially in remote regions. The technologies offer a flexible alternative to satellites, equipped with solar power, autonomous navigation and high-capacity communications technologies.	World Economic Forum. (2024, June 25). Top 10 emerging technologies of 2024.
Industrial Internet of Things	The industrial internet of things addresses issues like inefficiency, downtime and quality control by connecting physical devices, machinery, robots and vehicles with sensors, software and network connectivity. This network allows data exchange, enabling real-time monitoring, control and seamless interaction between devices.	EIT Manufacturing. (2023). Tech Radar.
Industrial Metaverse	The metaverse in manufacturing involves virtualising facilities and processes, from design to training and operations. It uses 3D modelling, extended reality and simulation to create virtual replicas of factories and machinery. This immersive, shared virtual space allows real-time interaction and collaboration among teams and stakeholders, regardless of location.	EIT Manufacturing. (2023). Tech Radar.

## Category: Information and Communication Technology

Technology Candidate	Description	Source
Internet of Things Device Edge	IoT device edge involves processing data locally on or near IoT devices instead of sending it to the cloud. This reduces latency, improves real-time decision-making and optimises bandwidth by transmitting only essential data. It allows devices to react instantly to change and function even without cloud connectivity. For instance, a smart sensor can detect temperature changes and immediately trigger a response, like adjusting a thermostat, without sending all data to the cloud.	McKinsey & Company. (2024). Technology trends outlook 2024.
Low- and No-Code Platforms	Low-code and no-code platforms enable users to create applications with minimal or no coding through visual interfaces and drag-and-drop features. This reduces development time, costs and time-to-market. Powered by artificial intelligence, big data and application programming interfaces, these platforms are ideal for building simple applications. However, they still need further development to support highly complex, custom solutions.	McKinsey & Company. (2024). Technology trends outlook 2024.
Machine Vision	Computer vision, or AI-based image recognition, enhances quality control by inspecting products on assembly lines for defects. It captures images or videos, analyses them for inconsistencies and triggers corrective actions in real-time. This reduces errors and ensures high-quality products. The same technology is used in Automated Guided Vehicles, Cobots, robots and worker safety monitoring, enabling machines to interpret visual data and respond accordingly.	EIT Manufacturing. (2023). Tech Radar.
Metro Edge / High Performance Data Storage and Data Centres	Metro edge data centres are decentralised infrastructure located near urban hubs, designed to process and store data closer to end-users. Unlike traditional data centres, they prioritise low-latency, real-time analytics and high-speed processing. These centres use edge computing, AI and high-performance storage to meet the demands of 5G, IoT and data-heavy applications. They provide scalable, energy-efficient and secure solutions for managing both structured and unstructured data, supporting modern digital services.	McKinsey & Company. (2024). Technology trends outlook 2024.
Microservices and Application Programming Interfaces	Microservices and Application Programming Interfaces are key technologies for scalable, flexible applications. Microservices break down apps into smaller, independent services focused on specific tasks, enabling faster development and scaling. Application Programming Interfaces act as the communication layer, allowing these services to interact. Together, they create modular, reusable systems, ideal for building complex, distributed applications.	McKinsey & Company. (2024). Technology trends outlook 2024.
Middleware	Middleware acts as a bridge between hardware and software in manufacturing, enabling seamless communication and data exchange between systems like sensors, controllers and enterprise software. As manufacturers modernise their IT architecture, middleware plays a key role in integrating diverse technologies. It ensures smooth data flow, enabling real-time monitoring, control and decision-making for operators and engineers on the factory floor.	EIT Manufacturing. (2023). Tech Radar.
Mixed Reality	Mixed Reality blends augmented reality and virtual reality, creating environments where physical and digital elements interact seamlessly. Using mixed-reality headsets, users can engage with both real-world and virtual objects simultaneously. This technology is key for applications like training simulations, collaborative design and immersive storytelling, offering an interactive way to explore complex data or environments.	Swiss Department of Defense. (2019). The Future of Supply Chain.
Mobility as a Service	Urban areas struggle with traffic, pollution and inefficient transport systems. Mobility as a Service addresses these issues by integrating different transport options public transit, ridesharing, bike-sharing and car rentals into a single on-demand platform. It allows users to plan, book and pay for various services through one app, transforming urban mobility.	Cappra Institute. (2024). Data Thinking Radar.

## Category: Information and Communication Technology

Technology Candidate	Description	Source
Neuromorphic Computing	Neuromorphic computing imitates the human brain's structure and function using artificial neurons and synapses. It enables low-power, parallel processing, making it ideal for tasks like pattern recognition and adaptive learning. This approach offers significant gains in energy efficiency and cognitive abilities for AI applications.	PwC. (2024). Emerging Technologies.
Predictive Maintenance	Predictive Maintenance uses data and advanced analytics to forecast equipment failures, allowing for timely repairs and eliminating unnecessary scheduled maintenance. By integrating sensors, IoT devices and machine learning, this technology continuously monitors equipment performance, collecting data on factors like temperature and vibration. Machine learning then detects patterns and anomalies, triggering alerts when maintenance is needed.	EIT Manufacturing. (2023). Tech Radar.
Proof-of-Stake Blockchain	As energy use and scalability concerns grow, traditional Proof-of-Work blockchain models are proving unsustainable for modern cities due to their high computational and electricity demands. Proof-of-Stake offers a more efficient, eco-friendly alternative by selecting validators based on the amount of cryptocurrency they stake as collateral, rather than relying on energy-intensive problem-solving. This shift greatly reduces energy consumption, making Proof-of-Stake blockchain more suitable for sustainable urban applications.	Cappra Institute. (2024). Data Thinking Radar.
Quantum communication	Quantum communication leverages the principles of quantum mechanics to enable highly secure data transmission. Unlike classical communication systems, it uses quantum bits (qubits) and phenomena like quantum entanglement and superposition to encode and transmit information. This approach makes eavesdropping detectable, as any attempt to intercept quantum information disrupts its state.	McKinsey & Company. (2024). Technology trends outlook 2024.
Quantum computing	Quantum computing uses quantum mechanics like superposition and entanglement to process data in ways that classical computers cannot. Unlike traditional computers that use binary (0s and 1s), quantum computers use qubits, which can represent multiple states at once, allowing for far greater processing power in certain tasks. This technology is expected to transform industries by solving complex problems that are too difficult for today's most advanced computers.	Hopkins, B., Lo Giudice, D., Harrington, P., Khater, Z., Cser, A., Goetz, M., Le Clair, C., Matzke, P., Pattisall, J., & Liu, S. (2024). The top 10 emerging technologies in 2024. Forrester.
Quantum key distribution / Quantum Security	Quantum key distribution is a subset of quantum communication specifically designed to enhance cybersecurity. It uses quantum mechanics to generate and share encryption keys that are theoretically unbreakable. These keys are transmitted via quantum channels, ensuring that any interception attempt is instantly identifiable. This technology is particularly valuable in protecting sensitive data in sectors like banking, healthcare and critical infrastructure. As quantum computers pose a future threat to classical encryption, quantum key distribution is emerging as a cornerstone of quantum-resistant security systems.	McKinsey & Company. (2024). Technology trends outlook 2024.
Quantum sensing	Quantum sensing uses the unique properties of quantum physics like superposition and entanglement to make highly accurate measurements of things like time, gravity, magnetic fields and motion. These sensors are much more precise than traditional ones and enable advances in areas such as navigation (e.g. quantum gyroscopes), medical imaging and environmental monitoring. They also support cutting-edge research, including detecting gravitational waves and studying new materials.	McKinsey & Company. (2024). Technology trends outlook 2024.

## Category: Information and Communication Technology

Technology Candidate	Description	Source
Responsible AI	Responsible AI, or Ethical AI, tackles bias and the “black box” issue in AI systems, ensuring decisions are fair and transparent. In manufacturing, it helps AI make unbiased choices in areas like hiring, resource management and supply chains. This is done by embedding ethical guidelines into AI algorithms and using explainable models so decisions can be understood and checked. Responsible AI also protects data privacy and security, especially for sensitive customer and production information.	Boston Consulting Group. (2023). The growth of the space economy.
Spatial Computing	Spatial computing blends the physical and digital worlds, enabling smooth interaction between people, machines and 3D spaces. It uses sensors like cameras, depth sensors, trackers and GPS to capture real-time data about the environment and the user’s movements. This data is processed with computer vision and spatial mapping to create a digital model of the physical space called a spatial map or point cloud helping the system understand the layout and features of the surroundings.	Cappra Institute. (2024). Data Thinking Radar.
Synthetic Data	Synthetic data is computer-generated data that looks and behaves like real-world data but doesn’t contain personal or sensitive information. It’s created by AI models trained on actual data like customer records or factory output in secure environments. These models learn patterns and relationships, then generate new data that keeps the same characteristics. Synthetic data can be numbers, images, or videos and is used to safely develop and test Big Data tools. Common methods include deep learning, generative adversarial networks (GANs) and statistical sampling.	EIT Manufacturing. (2023). Tech Radar.
Virtual Reality	Virtual reality is a technology that immerses users in a fully digital world, either real or imagined. Using devices like headsets, controllers and sensors, virtual reality creates an interactive 3D experience by blocking out the physical surroundings. Users can see, hear and sometimes feel the virtual environment. It is used in entertainment, education, healthcare and training to provide engaging and immersive experiences.	Swiss Department of Defense. (2019). The Future of Supply Chain.
Web 3.0	Web3, also called the decentralised or blockchain web, is the next evolution of the internet. Unlike Web2, which relies on central platforms controlled by big tech, Web3 gives more control to users and creators. It uses technologies like blockchain, smart contracts and machine learning to make the internet more open, secure and efficient. Web3 is closely tied to decentralised finance (DeFi) and fintech apps (dApps), emerging as trust in traditional institutions declines. More industries are exploring how to adapt to this growing and influential technology.	Information Services Group. (2024). Emerging Technology Consulting Solutions for Enterprises. ISG.
Wi-Fi 6 and 7	Wi-Fi 6 and Wi-Fi 7 are advanced wireless technologies that provide faster speeds, lower delays and greater capacity than earlier Wi-Fi versions. Wi-Fi 6 boosts performance in crowded places like offices and stadiums, while Wi-Fi 7 offers ultra-low latency and better support for things like 8K streaming, AR/VR and industrial IoT. These upgrades help meet the growing needs of more devices and data-heavy applications.	McKinsey & Company. (2024). Technology trends outlook 2024.
Wi-fi Sensing	Wi-Fi sensing helps cities monitor their environment in real time using existing Wi-Fi networks. Unlike traditional sensors or cameras that need extra infrastructure and upkeep, Wi-Fi sensing collects and transmits data through wireless signals already in place. This makes monitoring cheaper, easier and more energy-efficient, helping urban planners manage city life more effectively.	Cappra Institute. (2024). Data Thinking Radar.
Zero-trust Architecture	Zero-trust architecture is a cybersecurity model based on the idea of “never trust, always verify.” It means no user or device is trusted automatically, even inside a secure network. Instead, every access request is checked with tools like multi-factor authentication, identity checks and strict access controls. It also uses techniques like micro-segmentation to limit how far attackers can move within a system. This approach helps prevent data breaches and insider threats, making it ideal for today’s connected and remote-friendly IT environments.	McKinsey & Company. (2024, August 10). Technology trends outlook 2024.

### Category: Medical Technology

Technology Candidate	Description	Source
Brain Chip Implant	Brain chip implants are small, biocompatible devices placed in the brain to interact with neural signals. They can record, stimulate, or alter brain activity to help treat conditions like Parkinson's disease and epilepsy, restore senses such as vision or hearing, or enhance brain function. These implants work by detecting electrical signals from neurons, processing this information and sending precise electrical pulses to specific brain areas. This technology offers new possibilities for treating brain disorders, improving neuroprosthetics and developing direct brain-to-computer communication.	Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH. (2019). tech detector.
Health Monitoring Skin Patch	The health monitoring skin patch is a wearable device designed to continuously track physiological metrics such as heart rate, hydration, or glucose levels. Using advanced biosensors and wireless communication, these patches provide real-time data for personalised healthcare and fitness management. They empower users with actionable health insights and support medical professionals in remote monitoring, making them a vital tool in preventative healthcare.	World Governments Summit. (2019). Technology Radar.
Implantable Sensor	Implantable sensors are miniature devices embedded within the human body to monitor and regulate physiological conditions. These sensors provide continuous data on parameters like glucose levels, neural activity, or organ health, enabling precise diagnostics and interventions. Implantable sensors revolutionise personalised medicine by offering minimally invasive, real-time monitoring solutions.	World Governments Summit. (2019). Technology Radar.
Medical Nanobot	Medical nanobots are microscopic robots engineered to perform precise tasks within the human body. These nanobots can target specific cells for drug delivery, repair tissues, or eliminate harmful pathogens at a cellular level. They hold immense potential in precision medicine, enabling minimally invasive treatments, rapid diagnostics and revolutionary therapies for complex diseases like cancer.	World Governments Summit. (2019). Technology Radar.
Medical Tricorder	The medical tricorder is a portable, all-in-one diagnostic device inspired by science fiction, designed to rapidly analyse health metrics non-invasively. It uses advanced sensors and AI to provide real-time insights into a patient's condition, offering a transformative solution for remote healthcare, early detection and personalised treatment.	World Governments Summit. (2019). Technology Radar.

### Division: Social Sciences

### Category: Education

Technology Candidate	Description	Source
Sensing Classroom	The sensing classroom integrates sensors and AI to create smart learning environments that monitor factors like student engagement, environmental conditions and learning progress. This data-driven approach enhances teaching strategies and student outcomes, fostering more effective and personalised education.	World Governments Summit. (2019). Technology Radar.
Smart Classroom	Smart classroom technology uses digital tools to make learning more interactive, personalised and effective. It includes things like interactive whiteboards, tablets, online learning platforms and AI tools that adapt lessons to each student's needs. Teachers can use real-time data to give instant feedback and improve student progress. These tools also support virtual learning, group work and multimedia lessons, helping students stay engaged and learn in ways that suit them best. The goal is to create a modern, flexible classroom that supports better teaching and learning.	Clarivate. (2025). Derwent Innovations Index on Web of Science.  Clarivate. (2025). Innography IP Intelligence Software.

# APPENDIX E: LIST OF STEM SKILLS AND ESSENTIAL SKILLS

## List of STEM skills

STEM Area: Artificial Intelligence and Data Technologies		
STEM Skill	Definition	Source
Applied Data Science	This skill involves applying scientific methods, mathematics, programming and domain knowledge to extract insights from both structured and unstructured data. It includes using algorithms and machine learning for predictive modelling and communicating results through data visualisation to support innovation and informed decision-making.	Adapted by MIGHT from myMahir Platform, 2025 and Industrial Skills Framework, 2022.
Artificial Intelligence and Machine Learning Modelling	This skill involves developing systems and algorithms that mimic human intelligence to perform tasks such as perception, reasoning and decision-making. It includes using machine learning techniques and statistical models that allow systems to learn from data, make predictions or decisions and continuously improve without explicit programming.	Adapted by MIGHT from Industrial Skills Framework, 2022.
Cloud Computing	This skill involves designing, deploying and managing on-demand computing resources such as servers, storage, databases, networking and software delivered over the internet. It aims to enhance business performance, security, innovation and operational efficiency. This includes evaluating and implementing cloud solutions to support scalable, flexible and secure IT system.	Adapted by MIGHT from Future Skills Framework for the Malaysian Financial Sector, 2024 and Singapore Skill Framework, 2016.
Data Analytics and Visualisation	This skill involves interpreting and analysing data using statistical, mathematical and computational techniques to uncover patterns, trends and inefficiencies. It includes transforming insights into clear, engaging visual formats using narrative techniques and digital tools to support informed decision-making, communicate key messages and drive improvements across organisational and production environments.	Adapted by MIGHT from myMahir Platform, 2025 and Industrial Skills Framework, 2022.
Data Engineering	This skill involves designing, building and maintaining scalable data infrastructure and pipelines to collect, process, store and integrate data from various sources. It includes developing stable workflows to ensure efficient data transformation and accessibility, supporting analytics, AI systems and data-driven business objectives.	Adapted by MIGHT from myMahir Platform, 2025 and Industrial Skills Framework, 2022.
Data Governance	This skill involves establishing and implementing policies, standards and regulations to ensure data quality, privacy, security and accessibility throughout its lifecycle. It includes overseeing proper data handling, advising on compliance and addressing data breaches within complex and evolving organisational contexts.	Adapted by MIGHT from Future Skills Framework for the Malaysian Financial Sector, 2024 and myMahir Platform, 2025.
Generative AI and Large Language Models	This skill involves developing, fine-tuning and deploying generative AI models and large language models to automate and enhance tasks such as content creation, language understanding and decision support. It includes applying prompt engineering, managing training data, evaluating outputs and implementing responsible AI practices to ensure ethics, minimise bias and maintain compliance.	IBM. (2023). What is generative AI and large language models (LLMs).

## STEM Area: Computational and Physical Sciences

STEM Skill	Definition	Source
Aerospace Systems Maintenance and Integration	This skill involves applying aircraft maintenance practices and system integration procedures, in accordance with technical manuals, safety protocols and organisational standards. It includes ensuring safe operations within aircraft, hangar and workshop environments, using tools and equipment effectively, accurately interpreting engineering drawings and supporting quality assurance by utilising knowledge of APQP (Advanced Product Quality Planning) and PPAP (Production Part Approval Process).	Adapted by MIGHT from Singapore Skill Framework, 2016 and myMahir Platform, 2025.
Computational Modelling and Simulation	This skill involves developing, selecting and applying statistical techniques, algorithms and advanced computational methods to create virtual models that replicate real-world systems or scenarios. It includes simulating behaviours, interpreting data and using modelling techniques to analyse specific issues, generate insights and support data-driven decision-making.	Adapted by MIGHT from Singapore Skill Framework, 2016, myMahir Platform, 2025, Australian Skills Classification, 2021 and Malaysia National Skills Registry, 2021.
Kinematic Modelling	This skill involves the mathematical representation of motion without considering forces. It combines geometry, algebra and computational methods to predict and simulate an object's position and velocity over time.	Adapted by MIGHT from Industrial Skills Framework, 2022.
Mathematical and Statistical Modelling	This skill involves applying mathematical concepts and statistical techniques to represent, analyse and solve real-world problems across various fields, including engineering, IT, medicine, data science and commerce. It encompasses developing abstract models, performing quantitative and probabilistic analysis, interpreting data and using computational tools to make predictions and informed decisions.	Adapted by MIGHT from Industrial Skills Framework, 2022, myMahir Platform, 2025 and Malaysia National Skills Registry, 2021.
Quantum Science and Engineering	This skill involves the study of matter and energy at atomic and subatomic levels, governed by the principles of quantum mechanics such as superposition and entanglement. It forms the foundation for emerging technologies like quantum computing, communication and sensing, with transformative potential across fields such as cryptography, medicine and materials science.	University of Delaware. (2024). Quantum Science and Engineering.
Space Systems Engineering	This skill involves the interdisciplinary application of systems engineering to design, integrate and manage complex space missions. It includes coordinating subsystems such as propulsion, power, thermal control and communications, as well as performing critical tasks like calculating orbital trajectories for satellite deployment.	Adapted by MIGHT from O*NET, 2025.

## STEM Area: Digital Security and Cyber Defence

STEM Skill	Definition	Source
AI Governance	The skill involves the processes, standards and safeguards designed to ensure that AI systems and tools are safe, ethical and aligned with societal values. AI governance frameworks direct the research, development and application of AI to promote safety, fairness and respect for human rights, ensuring responsible and accountable AI usage.	Muchi, T. & Stryker, C. (2024). What is AI Governance? IBM.
Cybersecurity	This skill involves protecting digital systems and data by applying frameworks and practices to prevent, detect, respond to and recover from cyber threats. It includes ensuring regulatory compliance, securing interconnected environments and implementing measures such as encryption, penetration testing and secure system design.	Adapted by MIGHT from myMahir Platform, 2025, Industrial Skills Framework, 2022 and Singapore Skill Framework, 2024.
Data Governance	This skill involves establishing and implementing policies, standards and regulations to ensure data quality, privacy, security and accessibility throughout its lifecycle. It includes overseeing proper data handling, advising on compliance and addressing data breaches within complex and evolving organisational contexts.	Adapted by MIGHT from Future Skills Framework for the Malaysian Financial Sector, 2024 and myMahir Platform, 2025.
Network and Computer Systems Administration	This skill involves configuring, maintaining and optimising computer networks and systems, including LANs, WANs, servers and IT infrastructure, to ensure performance, security and availability. It includes monitoring system health, managing user access, diagnosing and resolving technical issues and supporting reliable operations across both physical and virtual environments.	Adapted by MIGHT from myMahir Platform, 2025 and O*NET, 2025.

## STEM Area: Energy and Engineering Infrastructure

STEM Skill	Definition	Source
Advanced Installation, Maintenance and Reliability Engineering	The skill involves the installation, maintenance and optimisation of mechanical systems using engineering practices that prioritise safety, reliability and performance. This encompasses deploying and validating cathodic protection systems, carrying out routine servicing and minor repairs and implementing reliability strategies to minimise downtime and prolong the lifespan of equipment.	Adapted by MIGHT from Industrial Skills Framework, 2022 and Australian Skills Classification, 2021.
Civil and Structural Engineering Management	This skill involves managing the planning, design, construction and maintenance of infrastructure projects by integrating engineering principles with management practices. It ensures that projects are completed on time, within budget and to the required standards. This field includes key aspects such as project scheduling, cost estimation, quality control and regulatory compliance.	Adapted by MIGHT from Ullah, N. (2024). Role in Management Civil Engineering. Medium.
Digital and Control Systems Engineering	This skill involves the design and implementation of systems that utilize digital computers and controllers to manage dynamic processes. It integrates principles from control theory, electronics and computer science to create systems capable of processing discrete signals and executing control algorithms. This enables precise and adaptive management of complex systems across various industries.	Adapted by MIGHT from ScienceDirect. (2017). Digital control system – an overview. In ScienceDirect Topics.
Electrical and Electronics Systems	This skill involves the design, development and maintenance of electrical and electronic systems by applying principles of electricity, electronics and electromagnetism. It encompasses creating and testing components such as circuits, microcontrollers and communication systems.	Adapted by MIGHT from U.S. Bureau of Labor Statistics. (2024). Electrical and Electronics Engineers. Occupational Outlook Handbook.

## STEM Area: Energy and Engineering Infrastructure

STEM Skill	Definition	Source
Marine and Offshore Engineering	This skill involves the design, construction, operation and maintenance of marine vessels and offshore structures by applying multidisciplinary engineering principles to ensure safety, reliability and sustainability in maritime and offshore environments.	Adapted by MIGHT from SkillsFuture Singapore. (2018). Skills Framework for Marine and Offshore.
Mechatronic Systems Integration and Design	This skill involves integrating mechanical, electrical, electronic and software components to design and develop intelligent mechatronic systems. It applies interdisciplinary engineering principles to create efficient, precise and adaptive solutions capable of performing complex tasks through seamless hardware–software interaction.	Adapted by MIGHT from Tech Briefs. (2009). Mechatronic System Integration and Design.
Process and Automation Control	This skill involves designing, implementing and managing hardware, software and systems to monitor, regulate and automate industrial processes for optimal safety, efficiency and quality. It includes applying instrumentation, sensors, actuators, control elements, real-time data, DCS, SCADA and loop control technologies across both continuous and batch operations.	Adapted by MIGHT from International Society of Automation. (2025). Process Automation and Control.
Renewable Energy Systems Engineering	This skill involves designing, developing and managing systems that harness renewable energy sources such as solar, wind, hydro and biomass to generate sustainable and efficient power. It requires integrating engineering principles with environmental considerations to optimise energy production, storage and distribution.	Adapted by MIGHT from New England Institute of Technology. (2023). Sustainability in Action: Renewable Energy Engineering.

## STEM Area: Environmental and Sustainability

STEM Skill	Definition	Source
Environmental Management	This skill involves developing and implementing comprehensive frameworks for environmental management systems, which include policies, standards and procedures, to ensure compliance with environmental regulations and promote sustainable practices within the organisation.	Adapted by MIGHT from myMahir Platform, 2025.
Geospatial Analytics	This skill involves collecting, analysing and visualising spatial data using technologies such as Geographic Information Systems (GIS), satellite imagery and remote sensing. It supports decision-making in fields like agriculture and environmental management by enabling the monitoring of crop health, mapping ecosystems and climate patterns and evaluating soil and water conditions.	Adapted by MIGHT from Industrial Skills Framework, 2025 and O*NET, 2025.
Green Chemistry and Sustainability	This skill involves designing safer chemical products and processes that minimise the use of hazardous substances, reduce environmental impact and improve resource efficiency, all while aligning with broader sustainability goals across various industries.	Adapted by MIGHT from United Nations Environment Programme. (2021). Green and Sustainable Chemistry: Framework Manual.
Life Cycle Assessment	This skill involves understanding Life Cycle Assessment which enables the evaluation of the environmental impact of field service activities and the identification of areas for improvement.	Adapted by MIGHT from myMahir Platform, 2025.
Waste and Hazardous Material Management	This skill involves the safe handling, treatment and disposal of waste and hazardous materials using validated processes and risk-based approaches. It ensures protection of human health, safety and the environment through rigorous risk assessments, regulatory compliance and sustainable waste management practices across industries.	Adapted by MIGHT from myMahir Platform, 2025.

## STEM Area: Food Security and Agricultural Systems

STEM Skill	Definition	Source
Agricultural Management	This skill uses scientific, technological and business strategies to improve farming operations. This involves leveraging agri technologies, applying Good Agricultural Practices, managing biosecurity risks and ensuring compliance with regulations to boost productivity and promote sustainability.	Adapted by MIGHT from Industrial Skills Framework, 2022, Singapore Skill Framework, 2016 and Malaysia National Skills Registry, 2021.
Food Engineering and Processing	This skill involves applying engineering principles to the design, optimisation and management of food production systems including processing, packaging, distribution and storage while integrating microbiology, chemistry and engineering knowledge to ensure food safety, quality and operational efficiency.	Adapted by MIGHT from Eurofins Scientific. (2024). Understanding Food Science Disciplines – What is Food Engineering?
One Health and Zoonotic Disease Management	An integrated approach that fosters collaboration between the human, animal and environmental health sectors to prevent, detect and manage diseases that can be transmitted between animals and humans (zoonoses), with the goal of improving overall health outcomes.	Adapted by MIGHT from Centres for Disease Control and Prevention. (2025). About One Health and Zoonotic Diseases.
Precision Agriculture	The use of advanced technologies such as drones, sensors and artificial intelligence to gather and analyse farm data. This enables accurate, efficient and sustainable management of resources and farming practices.	Adapted by MIGHT from Industrial Skills Framework, 2022 and Singapore Skill Framework, 2016.
Sustainable Farming	The creation of organisational sustainability goals, policies and plans, followed by the implementation of sustainable farming practices. This ensures that farming is conducted using best practices and protocols that prioritise clean energy, optimise water efficiency and minimise pollution and environmental impact.	Adapted by MIGHT from Singapore Skill Framework, 2016.

## STEM Area: Healthcare and Biomedical Sciences

STEM Skill	Definition	Source
Biomedical Product Development and Engineering	This skill involves the integration of engineering principles with biological and medical knowledge to design, develop and maintain medical devices and technologies. It focuses on addressing healthcare challenges through technological innovation, including areas like medical device design, diagnostic imaging and therapeutic interventions.	Adapted by MIGHT from Wilson, S. (2025). Biomedical Product Design & Development. University of Kansas Bioengineering Program.
Clinical and Medical Practice	This skill combines scientific evidence, thorough treatment plans and ongoing research. This method aims to improve health outcomes while ensuring adherence to the highest ethical principles and regulatory guidelines.	Adapted by MIGHT from myMahir Platform, 2025 and Malaysia National Skills Registry, 2021.
Diagnostic and Imaging Expertise	This skill involves capturing, interpreting and analysing diagnostic images using a range of imaging technologies to support accurate assessment and decision-making. It also encompasses computer-aided design (CAD) modelling skills, including the creation, manipulation and analysis of digital models for design, visualisation and simulation purposes.	Adapted by MIGHT from myMahir Platform, 2025.
Good Laboratory Practice Management	This skill involves a quality system that ensures the integrity, consistency and reliability of non-clinical laboratory studies through standardised procedures, thorough documentation and regulatory compliance. It is essential for generating credible data in areas such as chemical safety, environmental testing and pharmaceutical research.	Adapted by MIGHT from U.S. Environmental Protection Agency (EPA). Good Laboratory Practices Standards Compliance Monitoring Program.

## STEM Area: Healthcare and Biomedical Sciences

STEM Skill	Definition	Source
Multi-omics Integrated Analysis	This skill involves a comprehensive approach that integrates data from various biological domains such as genomics, transcriptomics, proteomics and metabolomics to uncover complex molecular interactions and pathways. This integration provides a deeper understanding of the flow of biological information from genotype to phenotype, improving the accuracy of disease diagnosis, prognosis and the development of targeted therapies.	Adapted by MIGHT from Subramanian, I., Verma, S., Kumar, S., Jere, A., & Anamika, K. (2020). Multi-omics data integration, interpretation and its application. <i>Bioinformatics and Biology Insights</i> .
Patient-Focused Services	This skill emphasises an integrated care approach that combines early detection, compassionate support and evidence-based clinical management. It is designed to ensure timely intervention, enhance patient experiences and promote sustained well-being across the continuum of care.	Adapted from Singapore Skill Framework, 2016, myMahir Platform, 2025 and LinkedIn Talent Insight, 2025.
Pharmaceutical Sciences	This skill combines the compounding and manufacturing of pharmaceutical products, patient-centered care and clinical research. It focuses on optimising the quality, safety and efficacy of drugs to improve therapeutic outcomes and advance healthcare solutions.	Adapted from myMahir Platform, 2025, LinkedIn Talent Insight, 2025 and Singapore Skill Framework, 2016.
Synthetic Biology	This skill involves the engineering of biological systems to create new functions or redesign existing ones for practical applications in fields such as medicine, agriculture and sustainability. It integrates biological science with engineering principles to design custom organisms, biological parts, or devices.	Adapted by MIGHT from National Human Genome Research Institute. (2019). <i>Synthetic biology</i> .

## STEM Area: Materials Science and Advanced Manufacturing

STEM Skill	Definition	Source
Advanced Materials Engineering	This skill involves applying principles of materials science and engineering to develop, process and test advanced materials with enhanced properties such as high strength, durability, thermal stability and electrical conductivity, for use in specialized applications across various industries.	Adapted by MIGHT from U.S. Bureau of Labor Statistics. (2024). <i>Materials Engineers</i> . <i>Occupational Outlook Handbook</i> .
Material Science	This skill involves investigating the properties, behaviour and performance of materials, which guides the selection and design of lightweight, durable structures for drones.	Adapted by MIGHT from Industrial Skills Framework, 2022.
Surface and Packaging Engineering	This skill involves designing, developing and evaluating surface treatments and packaging systems that improve product protection, functionality and visual appeal. It includes selecting suitable materials, applying surface technologies and ensuring compliance with industry standards.	Adapted by MIGHT from Creopack. (2025). <i>What is a Packaging Engineer and What Do They Do?</i>

## STEM Area: Smart Systems and Digital Transformation

STEM Skill	Definition	Source
Embedded Systems Development	This skill involves designing, developing and maintaining embedded systems that integrate hardware and software to perform real-time, dedicated functions. It includes system architecture, programming, interface and sensor integration, control implementation and testing to ensure reliable performance throughout the system's lifecycle, often operating without traditional operating systems.	Adapted by MIGHT from myMahir Platform, 2025, Singapore Skill Framework, 2016 and Industrial Skills Framework, 2022.
IoT Systems and Applications	This skill involves designing, implementing and maintaining interconnected devices and sensor networks that collect and exchange data in real-time to drive automation, predictive maintenance and operational efficiency. It includes integrating computing systems, equipment and machines within a networked environment to deliver targeted, data-driven solutions.	Adapted by MIGHT from myMahir Platform, 2025, O*NET, 2025 and Singapore Skill Framework, 2016.
Programming and Coding	This skill involves developing the technical capabilities to understand, design and write instructions for computers in the form of software programs to achieve desired outcomes. It includes using programming languages and coding techniques to create functional and efficient software solutions.	Adapted by MIGHT from Singapore Skill Framework, 2016 myMahir Platform, 2025 and Industrial Skills Framework, 2022.
Software Development and Testing	This skill involves designing, developing and testing software applications using development methodologies, computer science principles and testing techniques. It includes creating systematic test plans to ensure that the software aligns with design specifications and meets quality standards.	Adapted by MIGHT from Future Skills Framework for the Malaysian Financial Sector, 2024 myMahir Platform, 2025 and Singapore Skill Framework, 2016.
System Architecture and Design	This skill involves defining, designing and managing the structure, components and interactions of IT systems and digital platforms to meet business and user requirements. It includes developing system blueprints, selecting appropriate technologies and aligning infrastructure, applications, data and integration layers such as APIs, databases and cloud services.	Adapted by MIGHT from Future Skills Framework for the Malaysian Financial Sector, 2024 and myMahir Platform, 2025.
UX Engineering	This skill involves combining user experience design principles with front-end development skills to build interactive, accessible and technically feasible user interfaces. It includes prototyping UI components, implementing design systems, ensuring accessibility standards and translating design concepts into responsive, production-ready code.	Adapted by MIGHT from myMahir Platform, 2025 and Singapore Skill Framework, 2016.

## STEM Area: Strategic Planning and Risk Management

STEM Skill	Definition	Source
Applied Research and Development Management	This skill involves the strategic planning and oversight of research efforts focused on solving real-world problems and developing new products, technologies, or processes. It includes coordinating resources, teams and timelines to translate scientific knowledge into practical, market-ready innovations.	Adapted by MIGHT from National Science Foundation (NSF). (2022). Definitions of Research and Development: An Annotated Compilation of Official Sources.
Emergency and Disaster Preparedness	This skill involves planning, coordinating and executing strategies to prevent, mitigate and respond to crises or disasters. It emphasises ensuring the safety of people and assets, maintaining regulatory compliance and enabling the swift recovery and continuity of operations.	Industrial Skills Framework, 2022 and myMahir Platform, 2025.

## STEM Area: Strategic Planning and Risk Management

STEM Skill	Definition	Source
Energy Trading and Hedging Strategies	This skill involves managing risk and optimising value in energy markets through the use of financial instruments such as futures, options and swaps. It focuses on stabilising costs, securing profits and protecting against basis risk, delivery disruptions and price volatility to ensure reliable and efficient energy portfolio management.	Adapted by MIGHT from Academy Flex. (2025). Energy trading and hedging strategies.
Quality, Health, Safety and Compliance Management	This skill involves implementing and managing systems that uphold quality standards, health and safety regulations and environmental compliance. It focuses on identifying and mitigating occupational risks, driving continuous improvement initiatives and ensuring that operations align with ethical principles and regulatory requirements to protect people, products and the environment.	Adapted by MIGHT from Pouillard, N. (2024). OHSE: Definition, profession and quality, health, safety and environment management.
Strategic Technology Planning	This skill involves developing and steering long-term technology strategies that align with organisational goals, drive innovation and enhance overall performance. It includes identifying emerging technologies, assessing associated risks, setting strategic priorities and creating technology roadmaps that ensure security, scalability and a sustained competitive advantage.	Adapted by MIGHT from Future Skills Framework for the Malaysian Financial Sector, 2024 and myMahir Platform, 2025.
Technology Risk Management	This skill involves identifying, assessing and mitigating risks associated with existing and emerging technologies. It includes implementing structured processes for risk monitoring, review and reporting, as well as establishing proactive governance frameworks to safeguard systems, ensure regulatory compliance, strengthen resilience and maintain operational continuity.	Adapted by MIGHT from Securities Commission Malaysia. (2024). Guidelines on Technology Risk Management.
Workplace Safety and Health Management	This skill involves developing and implementing systems, frameworks and practices to identify, assess and control workplace hazards. It focuses on ensuring regulatory compliance, fostering a culture of safety and health and creating a sustainable work environment that protects the well-being of all employees.	Adapted by MIGHT from Industrial Skills Framework, 2022 and myMahir Platform, 2025.

## List of Essential skills

Essential Skill	Definition	Source
Adaptability and Resiliency	Navigate through the unexpected, respond positively to evolving challenges and recover from setbacks with flexibility and resilience.	Developed by MIGHT and adapted from Future Skills Framework for the Malaysian Financial Sector, 2024 and Singapore Skill Framework, 2016.
Analytical and Critical Thinking	Ability to analyse, interpret and draw conclusions.	Developed by MIGHT and adapted from Future Skills Framework for the Malaysian Financial Sector, 2024.
Collaboration and Teamwork	Managing relationships and working effectively with others to achieve goals.	Developed by MIGHT and adapted from Singapore Skills Framework, 2016, Malaysia National Skills Registry, 2021 and Future Skills Framework for the Malaysian Financial Sector, 2024.
Communication	Convey and exchange thoughts, ideas and information effectively through various mediums and approaches.	Developed by MIGHT and adapted from Singapore Skill Framework, 2016.
Creative and Transdisciplinary Thinking	Apply concepts from multiple disciplines by synthesising knowledge and insights to guide decisions, foster cooperation and drive continuous improvement, while adopting diverse perspectives to connect ideas across fields and generate innovative solutions and improvements.	Singapore Skill Framework, 2016.
Digital and Technology Literacy	Leverage digital technology tools, systems, software and hardware across work processes and activities to solve problems, drive efficiency and facilitate information sharing.	Developed by MIGHT and adapted from Singapore Skill Framework, 2016 and Future Skills Framework for the Malaysian Financial Sector, 2024.
Ethics and ESG Awareness	To practice professional integrity by ensuring innovations align with societal values and organisational policies while also understanding the principles of sustainable development and the implications of Environmental, Social and Governance (ESG) factors on the organisation.	Developed by MIGHT and adapted from Industrial Skills Framework, 2022 and Future Skills Framework for the Malaysian Financial Sector, 2024.
Foresight and Futures Thinking	Systematic participatory process, involving future intelligence gathering and building visions for the medium to long term future and aimed at informing present-day decisions and mobilising joint actions.	Developed by MIGHT, 2018.
Innovative Thinking and Problem Solving	Identifying complex problems and reviewing related information to develop and evaluate options and implement solutions.	Developed by MIGHT and adapted from Future Skills Framework for the Malaysian Financial Sector, 2024 and Malaysia National Skills Registry, 2021.
Learning Agility	Deploy different learning approaches which enable continuous learning across different contexts to drive self-development and the achievement of long-term career goals.	Singapore Skill Framework, 2016

# APPENDIX F: PRIORITISATION OF STEM SKILLS

## *Assessing the Attractiveness and Feasibility of STEM Skills for Malaysia's Future Economic Value*

The study identified 58 STEM skills with the potential to contribute to Malaysia's future economic value; however, their applications vary significantly. It is therefore essential to prioritise those with the greatest potential impact. In this context, the aim of prioritisation is to reduce the initial list of STEM skills to a set of prioritised skills that are most relevant against the applied criteria (adapted from UNIDO, 2005). To achieve this, a two-round Delphi survey was conducted to assess these skills based on their relevance to new and emerging industries, their potential economic impact in terms of job creation, wage growth and productivity and the anticipated demand over the next 10 to 15 years to enhance Malaysia's global competitiveness. The assessment also considered the readiness of the existing ecosystem to develop and deploy these skills, including the availability of training programmes and institutions, as well as their integration into current industries and ecosystems.

## DELPHI METHOD TO GATHER INSIGHTS AND ACHIEVE CONSENSUS

The Delphi methodology was adopted to systematically gather expert insights and achieve consensus on the prioritisation of STEM skills most critical for Malaysia's future economic value.

The UNIDO Technology Foresight Manual (2005) defined that Delphi method is based on structural surveys and makes use of the intuitive use of the intuitive available information of the participants, who are mainly experts. Therefore, it delivers qualitative as well as quantitative results and has beneath it explorative, predictive even normative elements. Delphi is an expert survey in two or more "rounds" in which in the second and later rounds of the survey of the results of the previous rounds are given feedback. Therefore, the experts' answers from second round are under the influence of their colleagues' opinion. Thus, the Delphi method is a "relatively strong structured group communication process, in which matters, which naturally unsure and incomplete knowledge is available, are judged upon by experts", (Hader and Hader, 1995). This Delphi method is particularly suitable for addressing complex, future-oriented

issues such as identifying emerging skills, as it leverages the knowledge of diverse experts through iterative rounds of evaluation and feedback.

By using this approach, the study assessed the attractiveness and feasibility of the initial list of STEM skills, ensuring that the prioritisation of STEM skill reflects both current realities and future needs for Malaysia's economic growth, workforce development and global competitiveness.

The Delphi survey engaged Malaysian academics, educators and training providers, industry leaders, human resource professionals, policymakers and researchers to ensure a comprehensive understanding of Malaysia's future STEM talent needs.

- **Academics** played a key role in innovating curricula, developing future-ready learning programmes and fostering collaborations to bridge skill gaps.
- **Educators and training providers** contributed by delivering practical, industry-relevant programmes and ensuring that learning pathways remain accessible and adaptable to evolving workforce demands.
- **Human resource professionals** offered expertise in talent acquisition, development and retention, ensuring a competitive and adaptable workforce.
- **Industry leaders** provided insights into emerging technological trends, skill demands and the practical requirements of future industries.
- **Policymakers** contributed by aligning workforce strategies with national economic and educational goals, anticipating technological and industry shifts.
- **Researchers** supported the process by generating evidence-based insights, analysing future trends and validating the relevance of STEM skills to Malaysia's long-term development.

In Round 1 of the Delphi survey, 58 STEM skills across 10 STEM areas were assessed by the respondents. A total of 754 responses were collected from 411 individuals, drawn from the 2,500 targeted participants across Malaysia.

### Total responses by organisation

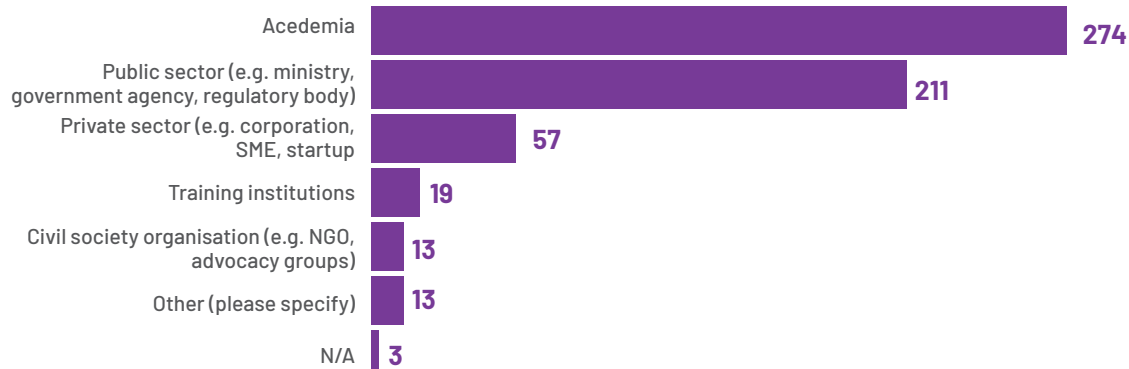


Figure F-1: Breakdown of responses by organisation type in Round 1.

### Total responses by stakeholder type

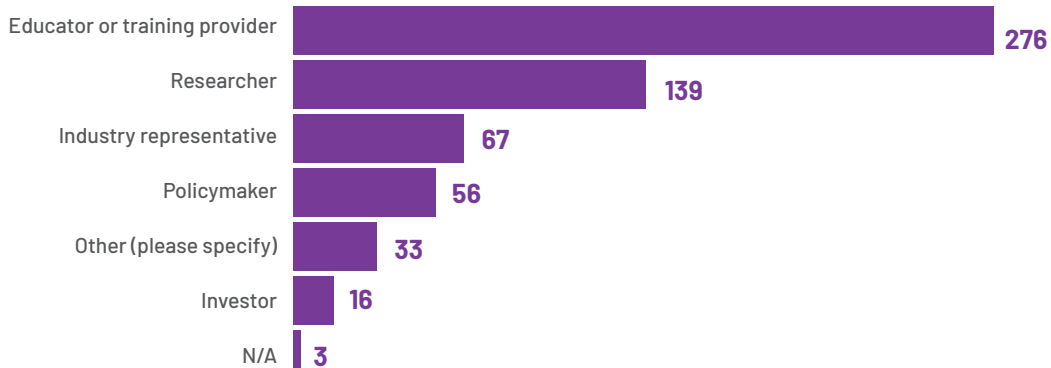


Figure F-2: Breakdown of responses by stakeholder type in Round 1.

### Total responses by STEM areas

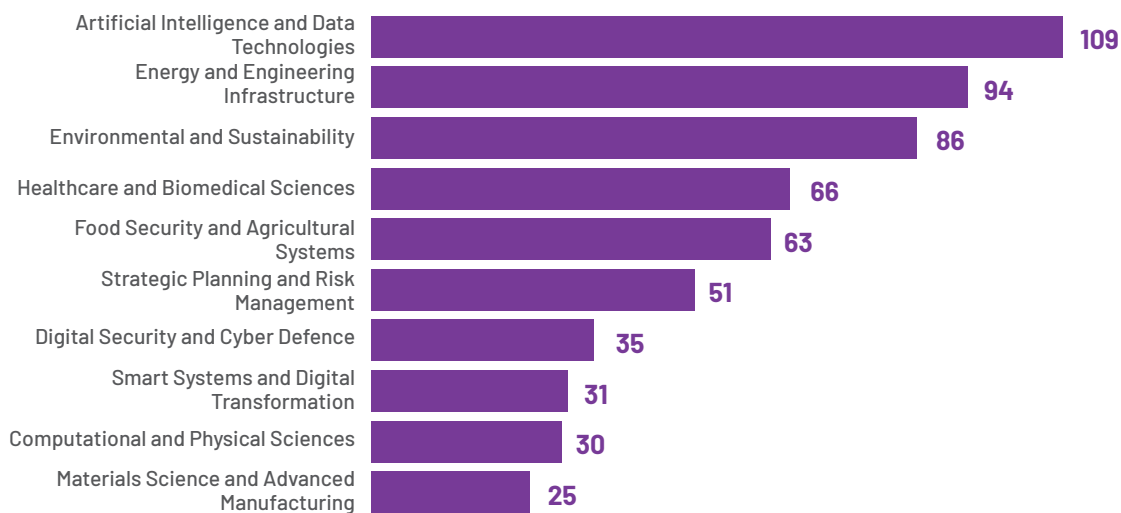


Figure F-3: Artificial Intelligence and Data Technologies garnered the highest number of responses in Round 1.

Following established Delphi methodology (Hsu & Sandford, 2007; Keeney et al., 2011), it is generally recommended that each item receive between 5 and 12 expert assessments to ensure statistical robustness and reliable group consensus. Consensus in Delphi studies is typically indicated when both the Standard Deviation (SD) and Interquartile Range (IQR) fall below 1.0. These thresholds signal a high degree of agreement among respondents and minimal variability in ratings, thereby enhancing the credibility of results by minimising the influence of outlier opinions and reinforcing a strong central tendency.

Applying these criteria, a subset of 40 skills, each rated by at least five experts and demonstrating SD and IQR values under 1.0 was shortlisted for reassessment in Round 2. This subsequent round garnered 379 responses (70% response rate), enabling further refinement and validation of the initial findings. However, 18 skills in Round 2 failed to meet the minimum threshold of five expert assessments and were consequently excluded from further analysis. This exclusion aligns with best practices in Delphi methodology, as inadequate expert input may undermine the reliability of the consensus and the overall validity of the findings (Okoli & Pawlowski, 2004).

**Responses by type of organisation in Round 2**

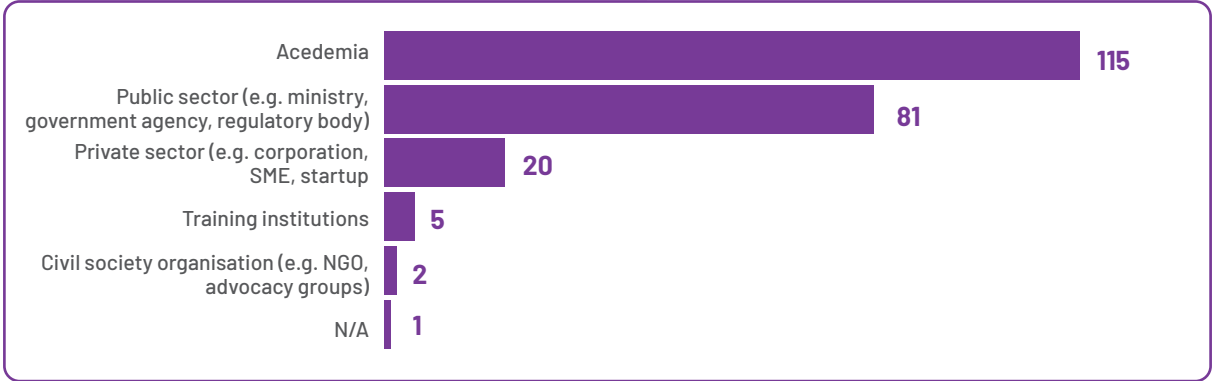


Figure F-4: Breakdown of responses by organisation type in Round 2.

**Responses by type of stakeholder in Round 2**

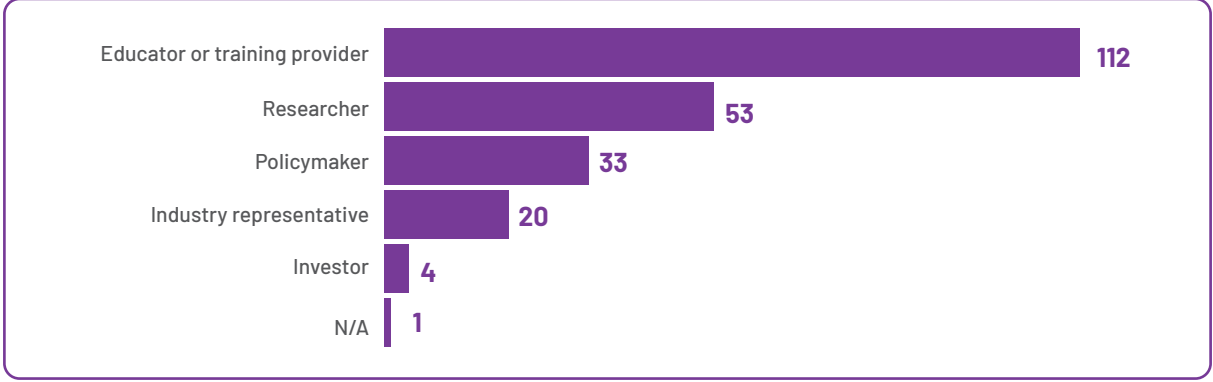


Figure F-5: Breakdown of responses by stakeholder type in Round 2

### Years of work experience (n=379)

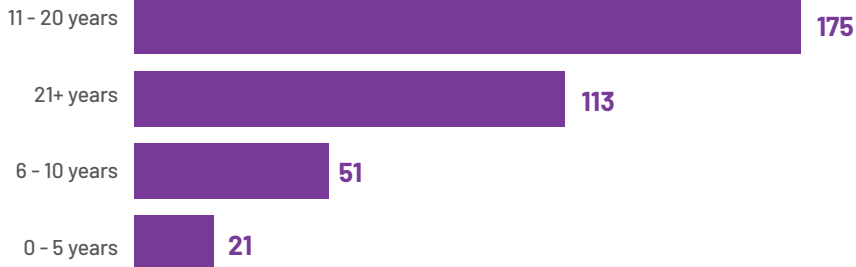


Figure F-6: Years of work experience of respondents, based on Round 2 responses.

In Round 2, the average mean and median for all 40 STEM skills were calculated for both attractiveness and feasibility parameters, with SD and IQR falling below 1.0. These thresholds indicate a high level of agreement among respondents and minimal variability in ratings, thereby enhancing the credibility of the results by reducing the influence of outliers and reinforcing a strong central tendency. The agreed prioritised STEM skills were then plotted in the attractiveness–feasibility matrix to determine their ranking positions as reflected in Figure F-7.

### Attractiveness-Feasibility of STEM skills for future economic value

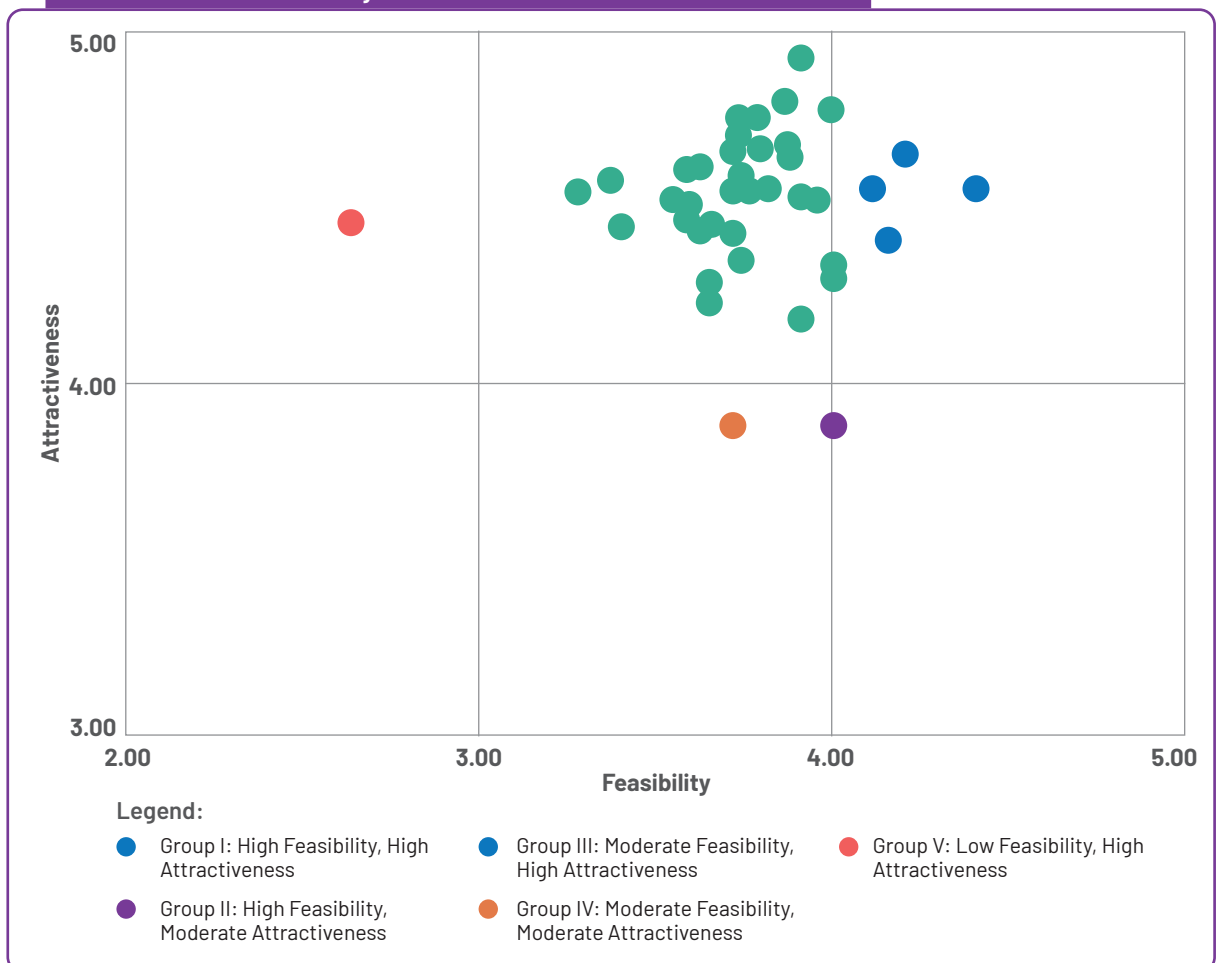
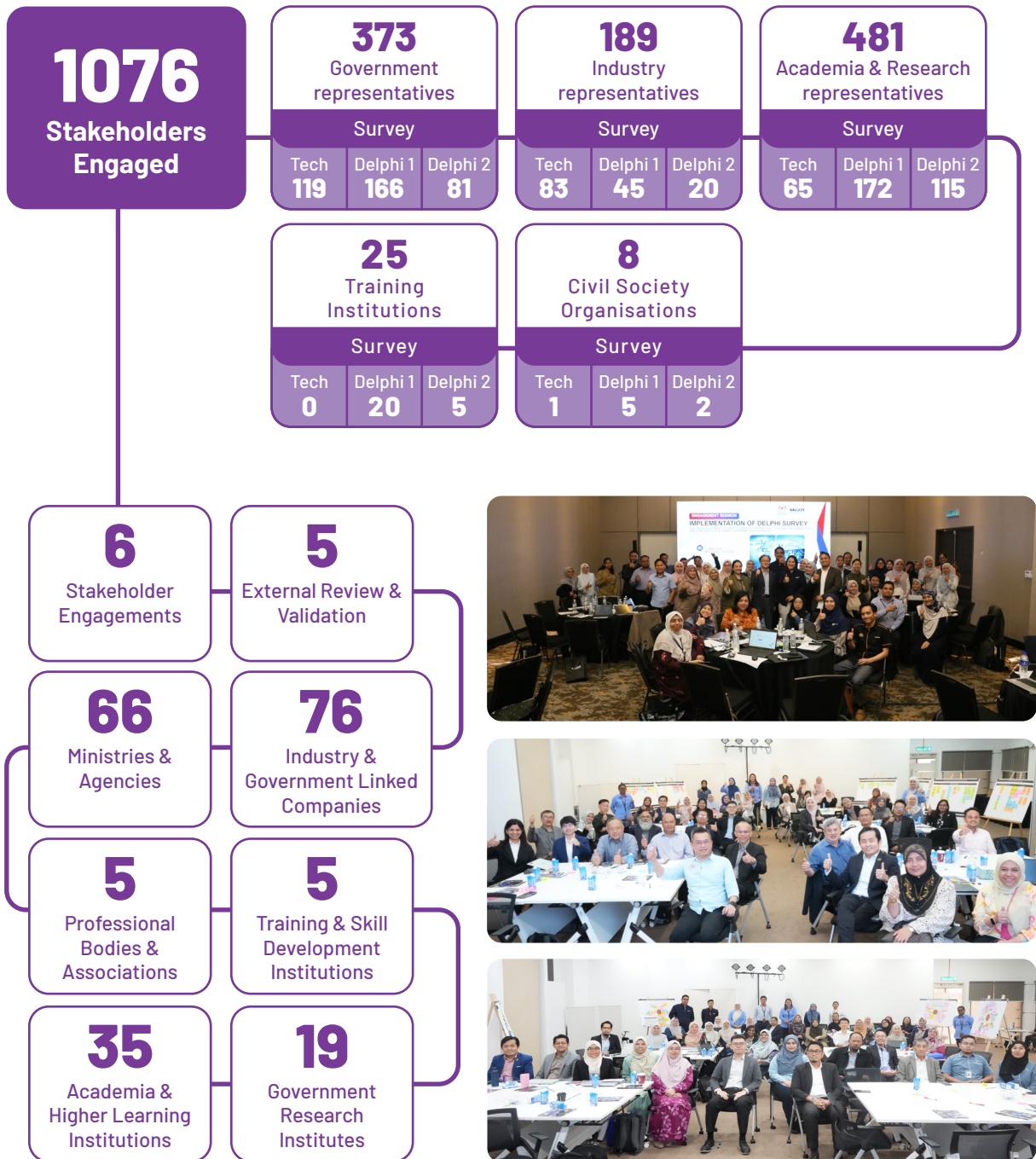


Figure F-7: Attractiveness-Feasibility of STEM skills for future economic value.

# APPENDIX G: LIST OF STAKEHOLDERS



## Academia & Higher Learning Institutions

1. ADMAL Aviation College
2. Monash University Malaysia
3. Multimedia University
4. Ibrahim Sultan Polytechnic
5. Ungku Omar Polytechnic
6. International Islamic University Malaysia
7. Islamic Science University of Malaysia
8. National Defence University of Malaysia
9. National University of Malaysia
10. Northern University of Malaysia
11. PETRONAS University of Technology
12. Putra University Malaysia
13. Sultan Idris Education University
14. Technical University of Malaysia Malacca
15. Tenaga Nasional University
16. Tun Hussein Onn University of Malaysia
17. Tunku Abdul Rahman University
18. University of Kuala Lumpur
19. University of Malaya
20. University of Malaysia Kelantan
21. University of Malaysia Pahang Al-Sultan Abdullah
22. University of Malaysia Perlis
23. University of Malaysia Sabah
24. University of Malaysia Sarawak
25. University of Malaysia Terengganu
26. University of Science Malaysia
27. University of Technology Malaysia
28. Sunway University
29. Taylor's University
30. UCSI University
31. UNITAR International University
32. University of Cyberjaya
33. University of Nottingham Malaysia
34. University of Technology Sarawak
35. University Malaya STEM Centre
36. Xiamen University Malaysia

## Government Ministries

1. Ministry of Agriculture and Food Security
2. Ministry of Defence Malaysia
3. Ministry of Digital
4. Ministry of Economy
5. Ministry of Education
6. Ministry of Energy Transition and Water Transformation
7. Ministry of Entrepreneur and Co-operatives Development
8. Ministry of Finance
9. Ministry of Health
10. Ministry of Home Affairs
11. Ministry of Higher Education
12. Ministry of Human Resource
13. Ministry of International Trade and Industry
14. Ministry of Natural Resources and Environmental Sustainability
15. Ministry of Plantation and Commodities
16. Ministry of Science, Technology & Innovation
17. Ministry of Youth and Sports
18. Public Service Department
19. Prime Minister Department

## Government Agencies

### Federal level

1. Academy of Sciences Malaysia
2. Angkatan Tentera Malaysia
3. Bank Pembangunan Malaysia Berhad
4. Bioeconomy Corporation
5. CyberSecurity Malaysia
6. Construction Industry Development Board Malaysia
7. Department of Atomic Energy
8. Department of Chemistry Malaysia
9. Department of Environment
10. Department of Fisheries Malaysia
11. Department of Irrigation and Drainage Malaysia
12. Department of Mineral and Geosciences Malaysia
13. Department of Polytechnic and Community College
14. Department of Statistic Malaysia
15. Department of Skills Development
16. Department of Standards Malaysia
17. Indah Water Consortium
18. Institute of Public Security of Malaysia
19. Invest Selangor
20. Malaysia Digital Economy Corporation
21. Malaysia Forest Fund
22. Malaysian Cocoa Board
23. Malaysian Investment Development Authority
24. Malaysian Palm Oil Board
25. Malaysian Pepper Board
26. Malaysian Productivity Corporation
27. Malaysian Qualifications Agency
28. Malaysian Research Accelerator for Technology and Innovation
29. Malaysian Rubber Board
30. Malaysian Space Agency
31. Medical Device Authority
32. Manpower Department
33. National Digital Department
34. National Science Centre
35. National Kenaf and Tobacco Board
36. Northern Corridor Implementation Authority
37. Royal Police Malaysia
38. SEDA Malaysia
39. Talent Corporation Malaysia Berhad

### State level

1. Chief Minister's Department of Sabah
2. Department of Agriculture Sarawak
3. Kedah State Government
4. Pahang State Education Department
5. Sarawak Digital Economy Corporation
6. Sarawak Forestry Corporation
7. Sabah Forestry Department
8. Sabah State Computer Services Department

## Government Research Institutes

1. Construction Research Institute of Malaysia
2. Collaborative Research in Engineering, Science & Technology
3. Defence Science & Technology Research Institute
4. Forest Research Institute Malaysia
5. Institute for Public Health
6. Institute for Medical Research
7. Institute for Strategic and International Studies Malaysia
8. Institute for Youth Research Malaysia
9. Khazanah Research Institute
10. Malaysian Agricultural Research and Development Institute
11. Malaysian Institute of Pharmaceuticals and Nutraceuticals
12. Malaysian Institute of Microelectronic Systems Berhad
13. Malaysian Institute of Road Safety Research
14. Malaysian Nuclear Agency
15. National Institutes of Biotechnology Malaysia
16. National Institute of Health
17. National Water Research Institute of Malaysia
18. SIRIM Berhad
19. Maritime Institute of Malaysia

## Industry & Government-Linked Companies

1. Advansoft Sdn Bhd
2. Aerodyne
3. AirAsia Magic
4. Agribolics Technology Sdn Bhd
5. Applied Agricultural Resources Sdn Bhd
6. Arex Precision Manufacturing (M) Sdn Bhd
7. Bonanza Venture Holdings Sdn Bhd
8. Brightstar Oils Sdn Bhd
9. Chip Hong Rubber Sdn Bhd
10. Composites Technology Research Malaysia Sdn Bhd
11. Continental Automotive Components Malaysia
12. Critical Manufacturing Malaysia Sdn Bhd
13. CTRM Aero Composites Sdn Bhd
14. Cyberview Sdn Bhd
15. Datasonic Group Berhad
16. Dindings Poultry Development Centre Sdn Bhd
17. Dream Edge
18. Dreamaze Sdn Bhd
19. Durabon Sdn Bhd
20. DZUKI Consultancy and Training
21. Easypack Machinery Sdn Bhd
22. eMooVit Technology Sdn Bhd
23. Favelle Favco Cranes (M) Sdn Bhd
24. FGV R&D Sdn Bhd
25. First Solar Malaysia Sdn Bhd
26. Forward Energy Sdn Bhd
27. Fuji Electric (M) Sdn Bhd
28. Green Point Precision (M) Sdn Bhd
29. Harimic (Malaysia) Sdn Bhd
30. HeiTech Padu Berhad
31. HICOM Automotive Manufacturers (Malaysia) Sdn Bhd
32. HICOM Holdings Berhad
33. Ideasparq Robotics Sdn Bhd
34. Indonesia-Malaysia-Thailand Growth Triangle (IMT-GT) JBC
35. IOI Edible Oils Sdn Bhd
36. IOT SATA Sdn Bhd
37. Johor Petroleum Development Corporation
38. Laurelcap Renewable Energy
39. Lim Chin Kiong M&E Sdn Bhd
40. Malaysian Chamber of Mines
41. McDermott Asia Pacific Sdn Bhd
42. Mechmar Boiler Sdn Bhd
43. Mobula Researach Sdn Bhd
44. Mycron Steel CRC Sdn Bhd
45. NanoMalaysia Berhad
46. Ngo Chew Hong Oils & Fats (M) Sdn Bhd
47. ON Semiconductor
48. Padiberas Nasional Berhad
49. PETRONAS
50. Proxima Technologies Plt
51. Prym Consumer Malaysia Sdn Bhd
52. Rufaida Medical Systems Sdn Bhd
53. S.E.H. Malaysia Sdn Bhd
54. Sarawak Oil Palms Berhad
55. SD Guthrie
56. Shin-etsu (Malaysia) Sdn Bhd
57. SilTerra Malaysia Sdn Bhd
58. Silicon Creation Sdn Bhd
59. SME Corporation
60. Solid Lab Sdn Bhd
61. Sony EMCS (Malaysia) Sdn Bhd
62. Southern Steel Berhad
63. Spirit AeroSystems Malaysia
64. Specific Resources Sdn Bhd
65. Superiorwealth
66. SWA Shipping Sdn Bhd
67. Tenaga Nasional Berhad
68. Texas Instruments Malaysia
69. Timuer Permai Holdings Sdn Bhd
70. Unipeq Sdn Bhd
71. United Plantations Bhd
72. Universal Nutribeverage Sdn Bhd
73. Ugeo Solutions
74. Via Scientia Sdn Bhd
75. Wasco Thermal Sdn Bhd
76. Yamagata (Malaysia) Sdn Bhd

## Training & Skill Development Institutions

1. National Youth Skills Institutes
2. Corridor Training & Consultancy
3. Petronas Leadership Centre
4. Sarawak Skills
5. MIMOS Academy

## Professional Bodies & Associations

1. Board of Geologist Malaysia
2. International Rubber Research Development Board
3. Malaysia Association for Information Systems
4. Malaysia Rail Industry Corporation
5. Technological Association Malaysia

## APPENDIX H: REFERENCES

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**Ministry of Science, Technology  
and Innovation (MOSTI)**  
Level 4, Block C5, Complex C,  
Federal Government Administrative Centre,  
62662 Putrajaya, Malaysia

+603-8885 8000  
[www.mosti.gov.my](http://www.mosti.gov.my)



**Malaysian Industry-Government Group for  
High Technology (MIGHT)**  
MIGHT Partnership Hub,  
Jalan IMPACT,  
63000 Cyberjaya, Selangor, Malaysia

+603-8315 7928  
[www.might.org.my](http://www.might.org.my)