
PENANG
STEM
TALENT BLUEPRINT
A Roadmap for Workforce Development
BERSATU DAN SETIA
PENANG 2030

PENANG STEM

Science • Technology • Engineering • Mathematics

TALENT BLUEPRINT

A Roadmap for Workforce Development

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making ideas work

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- Dato' Loo Lee Lian, CEO of InvestPenang
- Dr. Hari Narayanan, CEO of Penang Skills Development Centre (PSDC)
- Mr. Solomon Lorthu, Managing Director of Motorola Solutions Malaysia
- Mr. Richard Chung, CEO of Penang STEM
- Mr. SK Fong, Founder and CEO of SkyeChip
- Dato' CB Chuah, Founder and CEO of Pentamaster Corporation
- Ms. AK Chong, Managing Director of Intel Malaysia
- Mr. Suresh Kumar Dass, Vice President, Design Engineering Group of Intel Malaysia (a guest)

We acknowledge the invaluable strategic guidance and thought leadership provided by these top figures in the Penang STEM industry. Despite their demanding schedules, they selflessly dedicated their time and expertise to brainstorm innovative and transformative policy changes. Their insights into the evolving workforce needs of the engineering and technology sector were instrumental in shaping the future of Malaysia's STEM talent pool. Their commitment and knowledge were the foundation upon which this Blueprint was built.

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Over 10 stakeholder engagements and consultations were conducted from April to June 2024, which brought together industry associations, boards of state-linked STEM centres, educational institutions, and federal government agencies such as MIDA, MITI, MoF, and more. We are grateful to the over 300 industry leaders who participated in these sessions. Their willingness to share their industry expertise was essential in crafting this comprehensive roadmap for nurturing and empowering Malaysia's future STEM talent.

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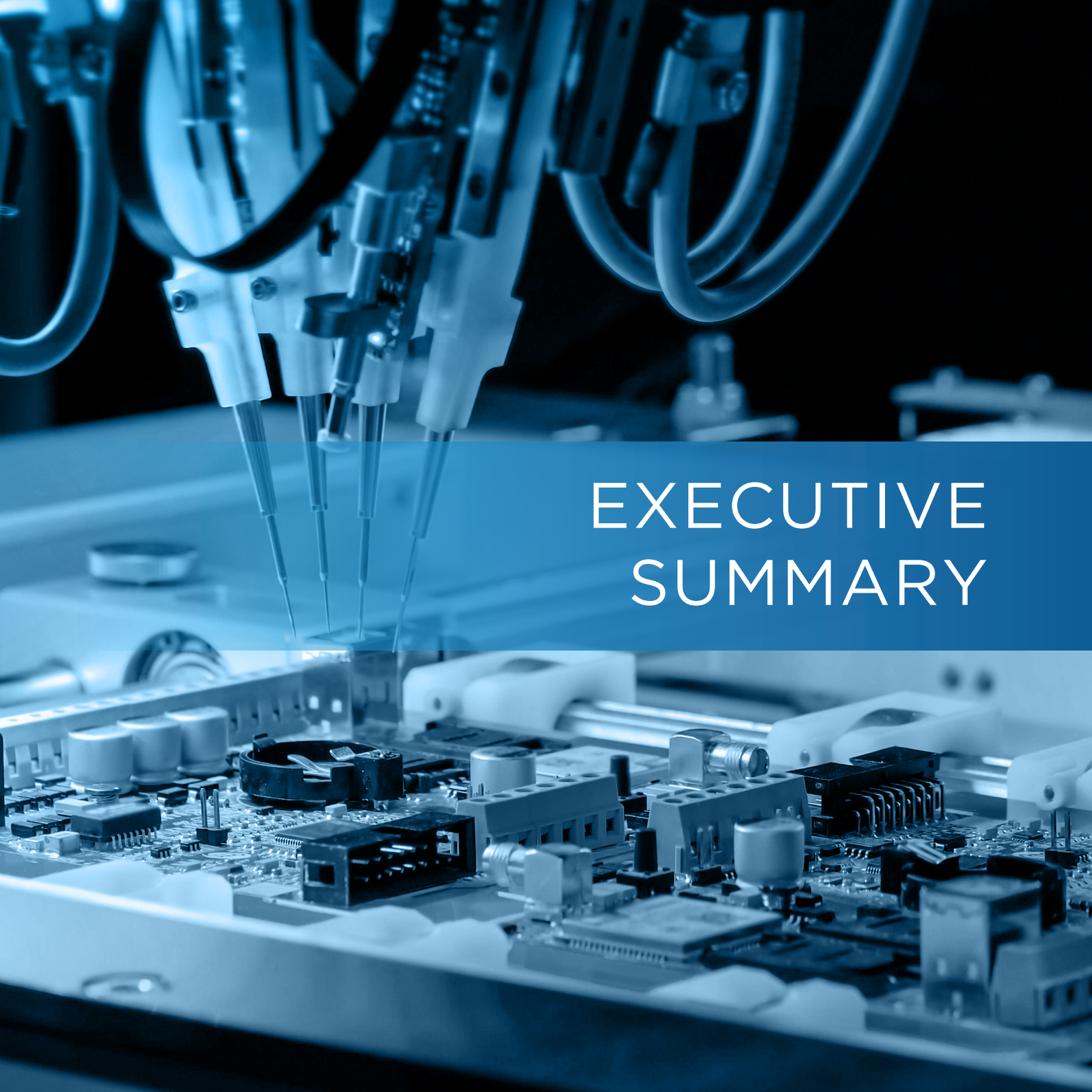
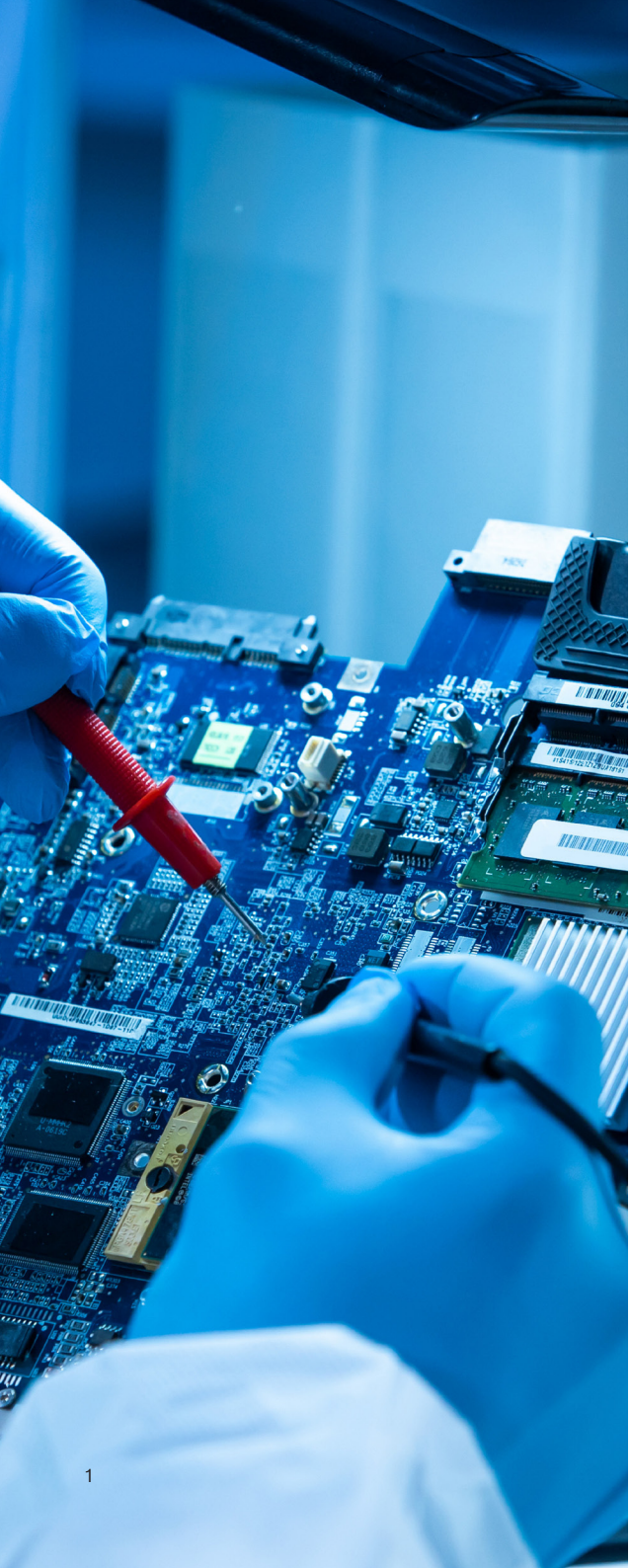


EXECUTIVE SUMMARY



The Penang STEM Talent Blueprint addresses the long-term talent and skills development of Penang's Science, Technology, Engineering and Mathematics (STEM) workforce, in support of the New Industrial Master Plan (NIMP) 2030 and the National Semiconductor Strategy (NSS). Being a major contributor to Malaysia's and the world's E&E sector, Penang's stakeholders understand the need for a strategic plan to meet that sector's growing talent and skill needs.

The Blueprint focuses on:

a. Attracting and retaining talent for multi-billion dollar investments in electrical and electronics (E&E)
b. Addressing the concerns of manufacturers and investors regarding talent availability and skill preparedness
c. Formulating a framework for identifying resources to meet specific STEM talent needs in Penang

The Vision

To build a highly skilled and sustainable STEM workforce for long-term success in an evolving industrial and technological landscape.

The Mission

The Blueprint follows the THRIVE principles (Transform, Hire, Retain, Invest, Value and Enable), which emphasise collaboration across government agencies to implement policies and frameworks to support STEM development. The six principles are elaborated below:

1. **TRANSFORM** the education system in
   a. primary and secondary schools
   b. higher learning institutions to specialise and focus on specific domains
2. Enhance the **HIRING** of STEM talents by enabling mobility in the country and international talents
3. Attract and **RETAIN** talents in STEM
4. **INVEST** in STEM education and upskilling/reskilling programmes to reduce skills mismatch
5. Optimise **VALUE** creation by adopting the latest technology across the manufacturing sector to move up the value chain
6. **ENABLE** governance framework to accelerate an ecosystem that attracts, retains and develops the STEM workforce

Emerging Trends

Fuelled by shifting global trade dynamics, Penang continues to be a major player in the E&E industry. The state's robust supply chain network, honed by over 50 years of industrial excellence, constitutes a compelling advantage. With a skilled workforce and supportive government policies, Penang has become a magnet for major foreign direct investments (FDIs), which continues to strengthen its position as the leading centre for the E&E and related supply chains within northern Peninsular Malaysia.

The huge influx of FDIs happens alongside at least five related trends:

a. Rising demand for skilled talents

- Following the implementation of de-risking, friend-shoring and China Plus One strategies by large economies, the flow of FDIs into Penang has intensified, increasing the demand for skilled talents within the state.
- The total approved manufacturing investments for Penang over the last five years (2019-2023: RM184 billion) have been more than twofold the investment approved in the decade of 2009-2018 (RM66 billion). The requirement for skilled talents has correspondingly increased.

b. Global swift and tactical response to talent-building initiatives

- Taiwan, South Korea, China and Vietnam have started various new STEM-related talent-building initiatives.
- This active intervention and investment in STEM education and talent development is in anticipation of an increasing shortage of talent and a widening skills gap in the semiconductor and technology industry. These countries also progressively look into government-industry-academia partnerships in semiconductor science, engineering and technology.

c. **Lack of STEM interest**
    - The declining overall interest in STEM among the young is concerning. There have been lower student enrolments in the pure sciences over the past decade and the share of students in the sciences has shrunk considerably in secondary schools.
    - Universities also face challenges filling the capacity of science and engineering programmes.

d. **Demographic shift towards old-age population and progressive migration policies in other countries**
    - There is a prevalent shift in demography towards aging populations. The working-age population is growing at a slower rate than the old-age population.
    - This is in addition to the progress of migration and attractive upskilling opportunities in neighbouring countries, which continuously attract Malaysians to work overseas.

e. **Shift towards the gig economy**
    - The rise of the gig economy creates alternative work arrangements and attracts talent away from mainstream jobs.
    - Global remote work options provide more flexibility for skilled workers.

Challenges

Key challenges in Malaysia's labour market include:

a. **Fragmented governance framework**
    - There is a lack of clear leadership and collaboration between federal and state agencies on STEM initiatives.
    - Duplication of initiatives and programmes has led to inefficient resource allocation.

b. **Lack of STEM talent-building strategies for engineering and technology**
    - Universities appear to lack the agility to introduce targeted programmes to meet the needs of evolving talent requirements e.g. high-value areas: IC design and advanced packaging.

- Local universities are not recognised for the best specific disciplines locally and internationally.

c. Quantitative mismatch between demand and supply for STEM graduates

- Student enrollment in STEM programmes is declining at all levels.
- Universities struggle to fill available engineering degree seats.

d. Mismatch of competencies between university graduates and job requirements

- University curricula do not keep pace with industry needs, leaving graduates with outdated skills.
- Graduates lack hands-on experience and struggle to find relevant jobs.

e. Non-competitive compensation packages

- The lack of attractiveness in compensation packages has led to a brain drain out of Penang.

Opportunities

Penang's economy thrives on the electrical and electronics (E&E) sector, and encompasses its entire value chain, from chip design (fabless/integrated design manufacturing) to final assembly and testing (back-end manufacturing, including advanced packaging, outsourced semiconductor assembly and test (OSAT), and equipment making).

Penang's target growth areas include:

a. IC design

- Penang to be positioned as a globally renowned hub for IC design through the **Penang Silicon Design @5KM+** initiative.

b. Machinery & equipment and IoT solutions

- Penang's E&E ecosystem expertise in electronics, mechanics, precision tooling and metal fabrication is to be raised.
- Local automation solutions serving Tier-1 multinational corporations (MNCs) to be scaled up.

c. Medical technology

- Penang to become a MedTech hub for Asia.
- Penang's high concentration of MedTech companies relative to the rest of Malaysia and Southeast Asia, which specialise in consumables, implants, surgical instruments, equipment and devices, and sterilisation, is to be taken advantage of.

Framework: Roadmap for a STEM Talent Pipeline

The Penang government is focused on constructing a robust and comprehensive STEM talent pipeline based on certain key elements for success:

- **IGNITE** interest in STEM through early education and a holistic, hands-on science learning experience among primary school children
- **EMBED** real-world science applications and vocational education through interactive pedagogy among secondary school children
- **IMMERSE** talents in real-world challenges by closing the gap between lecture and lab to industry reality
- **EMBRACE** lifelong learning through a proactive upskilling and reskilling approach to stay relevant in the job market
- **ENABLE** talent attraction and retention through state and federal policies

Key enablers, action plans and programmes are suggested based on the specific strategic outcomes required. These involve joint efforts from various STEM learning centres in the state, and federal ministries cutting across the Ministry of Finance, the Ministry of Investment, Trade and Industry, the Ministry of Home Affairs, the Ministry of Education, the Ministry of Digital, and the Ministry of Higher Education.

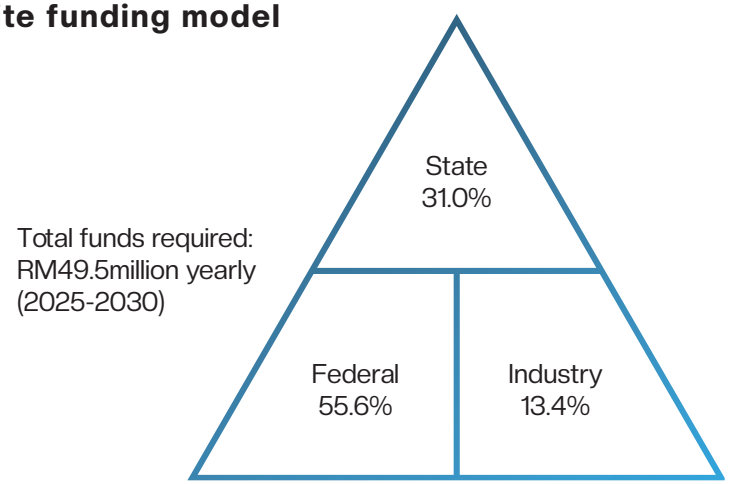
Penang STEM Governance and Delivery Framework

The Penang government has over the years established a collaborative and cohesive approach to STEM education. The structure led by Penang STEM prioritises close collaboration with schools, universities and industry partners.

Penang STEM is set to be a catalyst for a thriving STEM ecosystem that fosters collaboration and facilitates resource allocation, particularly for large-scale impact programmes tailored for diverse needs from lower-secondary to post-secondary education. Delivery of these programmes is entrusted to the three STEM centres: Tech Dome Penang (TDP), Penang Science Cluster (PSC) and Penang Math Platform (PMP) in partnership with universities, colleges and technical training institutions. Each centre brings its unique expertise towards ensuring a well-rounded learning experience.

Consistent funding is required for its three centres to achieve programme outcomes. A tripartite funding model is proposed, with the federal government contributing the most (55.6%), followed by state government and industry partners (31% and 13.4%, respectively) (Figure 1).

Figure 1: Tripartite funding model



To ensure effective programme delivery, the STEM centres are guided by outcome-based KPIs to eliminate programme duplication and the resource allocation is to follow **IGNITE, EMBED, IMMERSE,** and **EMBRACE** framework.

Table 1: Annual estimated funding requirements for STEM initiatives from 2025-2030 (RM million)

Initiatives	State	Federal	Industry
Penang STEM	0.2	10.8	-
Tech Dome Penang	10.5	6.0	2.1
Penang Science Cluster	0.4	0.8	4.0
Penang Math Platform	0.6	-	0.5
Penang Future Foundation	3.6	-	-
Penang Chip Design Academy*	-	-	-
TVET programmes	-	10.0	-
Total	**15.3**	**27.6**	**6.6**
% share	**31.0%**	**55.6%**	**13.4%**

Note: * This initiative is funded as part of the Penang Silicon Design @5KM+ initiative.

Table 1 illustrates the federal government is the biggest contributor to funding STEM initiatives in Penang, followed by the state government and industry. This suggests that the Malaysian government places a high priority on STEM education. The initiatives funded by the state and federal government include Penang STEM, Tech Dome Penang, Penang Science Cluster, and Penang Math Platform. Industry funding goes towards the three STEM centres for implementing STEM programmes and initiatives. Besides funding the large-scale programmes such as StepUP (RM3 million a year), STEM Future-Proofing (RM800,000 a year) and Technical Skill Learning (TSL) (RM7 million a year), Technical and Vocational Education and Training (TVET) programmes and Penang Chip Design Academy are proposed to be funded by the federal government.

Penang Future Foundation Scholarship: Cultivating Penang's Future Talent

Penang Future Foundation (PFF) is a scholarship programme run by the Penang state government to support outstanding and deserving Malaysians in pursuing their undergraduate studies. Since 2015, the scholarship programme has awarded a total of 751 scholarships. The programme supports approximately 60 outstanding students in each intake, giving each a generous RM60,000 scholarship. Notably, 80% of these scholarships go towards studies in Engineering, Science, Technology, and Mathematics (STEM), with the remaining 20% supporting students pursuing degrees in Accounting and Finance.

Over the next six years, from 2025 to 2030, about RM21.6 million in funds (or RM3.6 million yearly) are required to finance a maximum of 60 scholars per intake.

Penang Chip Design Academy: Building a World-Class Chip Design Workforce

Penang Chip Design Academy (PCDA) is one of the end-to-end semiconductor design development initiatives established by the Penang state government to address the growing demand for chip design engineers. It offers industry-focused training programmes to train fresh engineers and working professionals who may need upskilling or reskilling to move into the IC design discipline. PCDA's training programmes are developed in partnership with industry and premier Electronic Design Automation (EDA) tools vendor(s). PCDA will be equipped with state-of-the-art infrastructure and EDA tools to conduct the training programmes.

A matching fund model is proposed, with the government contributing initial funding and private sector co-funding in exchange for benefits such as curriculum development and recruitment opportunities. The Academy's initial establishment will require approximately RM3.4 million in capital expenses. To encourage graduates who are unemployed and have basic qualifications to embark on a career in IC design, **PCDA will require government funding of approximately RM2.3 million to train 100 engineers every year. In summary, RM11.5 million is needed to train 500 fresh engineers over the next five years.** PCDA will continue to enhance its portfolio of training programmes to cater to the needs of the industry.

PCDA is a strategic initiative that enables Penang's semiconductor design and development workforce. Essentially, it aims to attract Tier-1 IC design investments that offer high-paying jobs and thus position Penang as a leader in the chip design industry. This initiative is aligned with the national goals in the NIMP 2030 and the NSS of cultivating local IC design champions.

Tertiary education and TVET programmes: Bridging the Gap between Education and Industry

While the Penang STEM governance delivery framework focuses on igniting STEM interest and embedding real-world science applications, immersing students in tertiary education with industry reality is crucial for preparing a sustained and future-ready talent supply. For this, integrating AR/VR as part of the university's pedagogical approach and importing top-notch professors from overseas are among the key enablers proposed in this Blueprint. Additionally, new university degree programmes in IC design, semiconductor technology, AI and data analytics are also recommended for higher education institutions to keep pace with the rapid technological change.

Similarly, there is a need for greater emphasis and a new facelift on TVET programmes to support the increased requirements of technicians. The three most sought-after TVET programmes needed by industry in Penang include Precision Machining Technology (PMT), Industrial Automation Technology (IAT) and Quality Assurance Technology (QAT). Penang Skills Development Centre (PSDC) offers both certificate and diploma levels in these programmes. A unified grants approach to TVET institutions and allowances for TVET students are badly needed. There is increasing demand for technicians; about 3,000 technicians are needed to be trained from 2024, with an incremental increase of 500 technicians yearly.

Training an additional 2,500 TVET graduates is estimated to cost RM60 million from 2025-2030 (or RM10 million annually). This amount accounts for a training cost of RM24,000 per student for 2.5 years.

In conclusion, the Penang STEM Talent Blueprint outlines the opportunities and strategic directions for nurturing Penang's future STEM workforce. It identifies recommendations for policy change for the state and federal governments across various ministries to address the root causes of talent shortages and build the STEM talent pipeline. A whole-of-government and cohesive collaboration between government agencies, industry leaders and educational institutions is essential to attract and retain top talent, narrow the skills gap through targeted training programmes and promote STEM education at all levels. By implementing the initiatives outlined in this Blueprint, Penang can position itself as a leading hub for innovation and talent, and help Malaysia strengthen its STEM talent pipeline.

INTRODUCTION

1 INTRODUCTION

1.1 What is the Blueprint for?

Human capital development is vital for Malaysia to accelerate the next level of growth and prosperity. The fourth industrial revolution has changed how we use human capital, and created a new frontier for education that must adapt quickly to meet changing skill requirements. At the national level, the New Industrial Master Plan (NIMP) 2030 has outlined the targeted and focused action plans across various manufacturing and related services sectors for the next six years. However, some key questions remain:

a. What human capital strategies are needed for alignment with NIMP 2030's goals?
b. How can sustainable and future-ready STEM talents be created to meet the objectives of NIMP 2030?
c. How do we build a talent-friendly ecosystem to retain and attract talent?

Given that Penang's GDP for electrical and electronics (E&E) constitutes 40% of Malaysia's, this talent development roadmap for Penang is urgently needed in support of NIMP 2030 and the new National Semiconductor Strategy (NSS). It calls for the nation and policymakers to focus on evolving educational and human capital needs to support the multi-billion dollar investments approved annually, especially in semiconductor supply chains. Progressive engagement and implementation of programmes through tripartite initiatives involving government, industry and academia are urgently needed.

This Blueprint addresses the long-standing concerns of manufacturers and potential investors, particularly regarding talent availability and the preparedness of the workforce in science, technology, engineering and mathematics (STEM).

It provides a framework to address long-term talent needs and development and immediate measures, specifically in STEM.

1.2 Objectives of the Blueprint

This Blueprint aims to:

a. Assess the current performance and challenges of the STEM workforce;
b. Establish clear aspirations for STEM workforce development; and
c. Propose holistic, sustainable and transformational programmes for STEM workforce development.

1.3 The Vision

The Penang STEM Talent Blueprint envisions solidifying the state's existing economic action plans and programmes by investing in the workforce and enhancing skills matching, with a special focus on STEM.

The Blueprint aspires:

To build a highly skilled and sustainable STEM workforce for long-term success in an evolving industrial and technological landscape

This Vision is curated in line with the aspirations set in Penang2030—Theme B: Upgrade the Economy to Raise Household Incomes—and the Penang Strategy Economic Ecosystem Development (Penang SEED) 2023-2028. Penang SEED, in turn, identified the need for Penang to strengthen its industrial ecosystems, and focus on short-term measures as well as long-term goals.

1.4 The Mission

The Blueprint adopts the THRIVE principles (Transform, Hire, Retain, Invest, Value and Enable). These call for close collaboration between related federal and state government ministries and executors to drive a set of enablers, initiatives, programmes and strategies to achieve a sustainable STEM talent pipeline. The six principles of THRIVE are as follows:

1. **TRANSFORM** the education system in
   1. primary and secondary schools
   2. higher learning institutions to specialise and focus on specific domains
2. Enhance the **HIRING** of STEM talents by enabling mobility in the country and international talents
3. Attract and **RETAIN** talents in STEM
4. **INVEST** in STEM education and **INVEST** in upskilling/reskilling programmes to reduce skills mismatch
5. Optimise **VALUE** creation by adopting the latest technology across the manufacturing sector to move up the value chain
6. **ENABLE** governance framework to accelerate an ecosystem that attracts, retains and develops the STEM workforce

NAVIGATING TALENT TRENDS, CHALLENGES AND OPPORTUNITIES

2 NAVIGATING TALENT TRENDS, CHALLENGES AND OPPORTUNITIES

2.1 Emerging Trends and Talent Landscape

The global semiconductor market is expected to double by 2030, reaching USD1 trillion, up from USD550 billion in 2022. Assuming that all other conditions remain the same and that Malaysia maintains its current competitive advantage, projections indicate that the country's electrical and electronics (E&E) exports could double to USD297 billion (or RM1.2 trillion) by 2030, up from USD125 billion (or RM575 billion) in 2023. This trend is fuelled by accelerating technological advancements and the increasing demand for electronic devices and systems in various sectors.

Penang has a proven track record of over 50 years of industrial excellence and technical expertise, attracting more than 350 multinational corporations (MNCs). Contributing over 7% of the global semiconductor market share, the influx of foreign direct investments has enriched the semiconductor manufacturing ecosystem and brought significant multiplier effects to over 4,000 locally grown companies. Penang has also become an economic magnet for the neighbouring states in northern Peninsular Malaysia. On average, its E&E exports contribute over half of Malaysia's E&E exports.

Figure 2.1: Malaysia's major semiconductor export markets

7% of total global semiconductor trade flows through Malaysia

13% of global chip assembly, testing & packaging done in Malaysia, majority based in Penang

>50% SEA's packaging and testing activities in Malaysia

12th largest exporter of E&E products worldwide

6th largest semiconductor exporter worldwide

Source: Adapted from Penang: The Next Design Hub by InvestPenang (26 March 2024), MATRADE press release May 24, 2023, Developments in the Malaysian Economy, Bank Negara Malaysia (BNM) and Malaysia Semiconductor Industry Association (MSIA) 2022 E&E Survey (21 February 2023).

Boasting three of the world's top 10 semiconductor giants and five of the leading 10 global medical device companies (by sales), Penang has rightfully earned the moniker of "Silicon Valley of the East." This dynamic hub for tech-enabled and innovation-driven industries is poised for continued growth,

with its robust ecosystem attracting new players across the entire E&E and related supply chain. This influx of companies not only fosters collaboration and knowledge sharing but also creates high-quality job opportunities for Malaysians, propelling the nation's technological advancement. Below is the talent landscape in Penang and Malaysia.

1. **Rising demand for skilled talents**

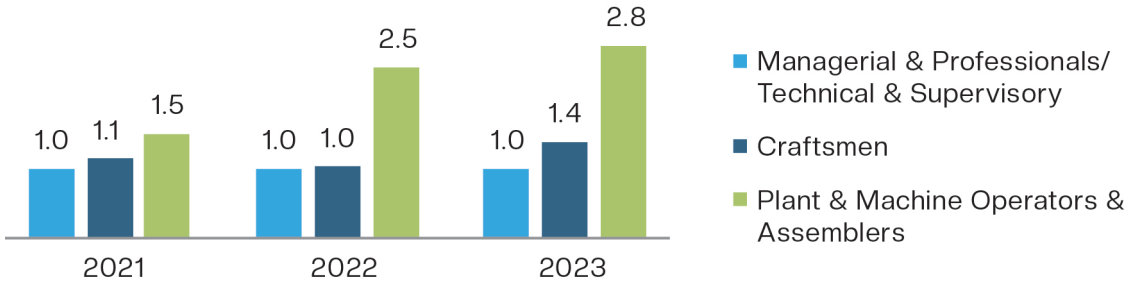
   Geopolitical tensions between the US and China are creating a golden opportunity for Malaysia, specifically Penang. It is attracting investments at a faster rate than ever before, due to its established strengths in semiconductor manufacturing and its skilled technical workforce. Companies are increasingly adopting strategies like "de-risking" (reducing dependence on a single country), "friend-shoring" (shifting production to allied nations), and the "China Plus One Strategy" (diversifying production beyond China). These trends are fueling an investment boom in Southeast Asia, with Penang well-positioned to reap significant benefits.

   Penang has been attracting more than twofold the investment approved for the decade of 2009-2018 (RM66 billion). From 2019-2023, a total of RM184 billion worth of investments were approved in the manufacturing sector, which is estimated to have created about 78,000 jobs over the last five years. In 2023, nearly 60% of the jobs created were in the E&E industry, with another 1,600 jobs created in managerial, professional, and technical positions.

   In terms of value creation, the approved investments over the past three years are in areas of considerably higher value. A general rule of thumb is that one technologist should be equal to five technicians and 25 craftsmen in production engineering.[1] Taking the number of new high-skill jobs created as a proxy, Penang's investments created the average ratio of one high-skilled worker to 1.2 craftsmen and 2.3 plant/machine operators/assemblers from 2021-2023. Figure 2.2 illustrates the ratio of new jobs created from 2021-2023.

1 Manpower Planning and the Technician (n.d.). Retrieved from https://www.thecommonwealth-ilibrary.org/index.php/comsec/catalog/download/726/726/5504?inline=1#:~:text=Thus%20in%20production%20engineering%20the,ten%20craftsmen%20to%20one%20technician

Figure 2.2: The ratio of new jobs created from 2021-2023



Note: Managerial & professionals may not only be exhaustive for technologists/engineers.
Source: Penang Institute's calculations based on InvestPenang and MIDA data.

Penang stands out as the national leader in the E&E sector, generating over a third (35.8%) of the industry's value in 2021. This translates to RM34.5 billion out of a total of RM89.5 billion produced nationwide. Each employee in Penang's E&E sector contributes approximately RM220,000 in value creation.

The impact of Penang's E&E strength extends beyond its borders. Neighbouring states like Kedah benefit from the spillover effect of this established and vibrant ecosystem. Kedah contributes 9.6% of the sector's value-added, and each employee generates an even higher value of RM245,000 because of the growing wafer fabrication activities. Anecdotal evidence suggests a rising trend of Penang residents commuting daily to work in Kulim Hi-Tech Park, Kedah.

2. **Global swift and tactical response to talent-building initiatives**

   The shortage of talent and the skills gap in the semiconductor industry are universally recognised challenges. Universities in Taiwan, India, China, Vietnam, South Korea, and the US are addressing these issues through proactive and progressive industry-academia partnerships backed by strong government support. Examples of other countries' initiatives include:

1. Taiwan

The Taiwanese government is estimated to invest US$33 million in new graduate courses over the next 12 years. Three new semiconductor research centres in advanced technologies are being established at the National Taiwan University (NTU), National Tsing Hua University (NTHU), and National Cheng Kung University. Additionally, an Academy of Innovative Semiconductor and Sustainable Manufacturing was established at National Chen Kung University in October 2021 in collaboration with 15 top companies.

2. South Korea

South Korea's government allocated US$42 million for eight universities in the country to specialise in semiconductor programmes, including the initiative to increase the undergraduate student quota by an additional 2,000 places.[2] The government also amended its Industrial Education Enhancement and Industry-Academia-Research Cooperation Promotion Act to allow 20% of the existing programmes based on contracts that permit universities to offer courses that companies desire. Apart from new semiconductor programmes, the Korean government also set aside US$390,000 for each of 12 newly selected ICT research centres in universities to cover the training of 3,300 key talents in areas such as artificial intelligence, semiconductors, cyber security, quantum information communication, healthcare ICT, and energy ICT. Meanwhile, in collaboration with big corporations like Samsung or SK Hynix Inc., new semiconductor degrees commenced at Yonsei University and Korea Advanced Institute of Science and Technology (KAIST).

3. China

In 2024, the Chinese government set up about US$48 billion to build up the local semiconductor supply chain and close the technology gap in China due to limited

2 Jung, Unsoo. (2023, March 23). Government ups investment in semiconductor training. *University World News*. Retrieved from https://www.universityworldnews.com/post.php?story=20230323131213777

access to the US's advanced semiconductors and chip-manufacturing equipment.[3] China prioritises semiconductor science and engineering in academic programmes. Many initiatives are implemented to refocus their institutes of higher learning towards IC Design. For instance, Shenzhen Technology University set up an IC Design and Manufacturing School; Tsinghua University established the School of Integrated Circuits; Fudan University and Peking University introduced Integrated Circuits Science and Engineering; Nanjing Integrated Circuit University was set up in 2020; Beihang University renamed its School of Microelectronics to IC Science and Engineering; and Shandong University and South China Normal University established semiconductor institutes in 2019.

4. Vietnam

Vietnam aims to invest nearly US$1 billion in training 50,000 semiconductor engineers by 2030.[4] The Vietnamese government works closely with domestic and foreign partners to support universities and training centres in the country. The world's leading chip design software suppliers such as Synopsys and Cadence have inked to provide copyrighted software to universities to develop training programmes. For example, Synopsys collaborated with Da Nang City to deliver a university software programme, which includes software, curriculum, educational resources, and a "train the trainers" offering to support the IC Design Incubation Center.

Additionally, the government collaborates with Google to offer some 40,000 scholarships to university students. Furthermore, Hanoi National University, Ho Chi

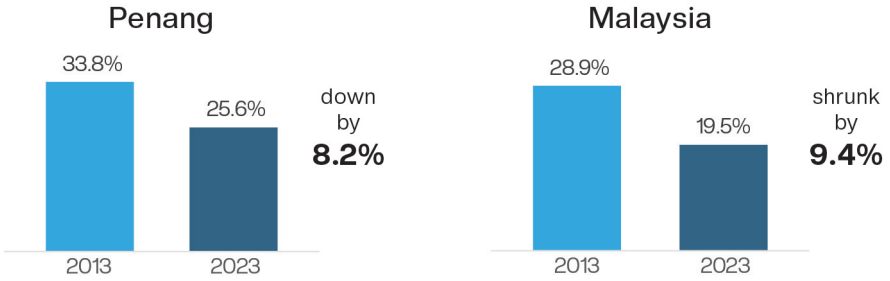
3 Tuoi Tre News (2024, April 20). *Vietnam to invest $1bn in training 50,000 semiconductor engineers*. Retrieved from https://tuoitrenews.vn/news/business/20240420/vietnam-to-invest-1bn-in-training-50000-semiconductor-engineers/79462.html

4 Tuoi Tre News (2024, April 20). *Vietnam to invest $1bn in training 50,000 semiconductor engineers*. Retrieved from https://tuoitrenews.vn/news/business/20240420/vietnam-to-invest-1bn-in-training-50000-semiconductor-engineers/79462.html

Minh City National University, Hanoi University of Science and Technology (Faculty of Circuit Design) and FPT University (Department of Semiconductor Circuit) are earmarked to produce talents for the semiconductor industry.

3. Lack of STEM interest

The low interest in STEM among secondary school students in Penang is alarming. Enrolment in pure science has been shrinking. It shrank at a faster rate than the shrinking of the entire number of students enrolling at the upper secondary level. Penang's total student enrolments for Form 4 and 5 dropped by 18.5% from 45,144 students in 2013 to 36,778 students in 2023, while enrolment in pure science dropped even more significantly by 38% for the same period.

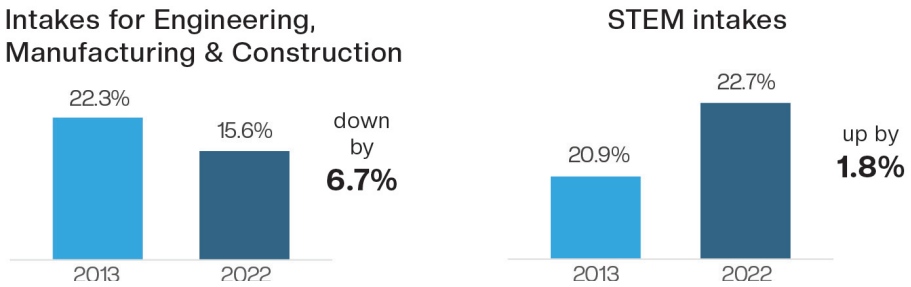


The Ministry of Education (MOE) has recategorised the streaming of STEM students using STEM Option A, B and C. Option A consists of students who take pure science subjects i.e. Biology, Physic, Chemistry and Additional Mathematics, while Option B consists of students who sign up for any two pure science subjects and Additional Mathematics plus one STEM elective or non-STEM elective. Students who choose Option C study none of the pure science subjects but are instead taking two applied science and technology subjects or one vocational subject, as illustrated in Appendix A. Based on the latest statistics, Penang's Form 4 and 5 students in STEM A and STEM B are 27.2%, with the former representing 23% while the latter is 4% in 2024.

4. **Significant decline in engineering intake in Malaysian universities**

Despite an overall increase of 5.5% in university intakes (including polytechnics and community colleges) from 2013 to 2022 (reaching 394,000 students), universities continue facing challenges in filling the capacity of engineering programmes. In fact, engineering intakes (including manufacturing and construction) have significantly declined by 26% in 2022 compared to 2013. This decline is particularly evident in E&E and related degrees, with universities graduating only 5,500 students in 2022, where public universities contributed about 4,000 of those graduates. Conversely, intakes in science, mathematics, and computing have risen by 8.9%, reaching 55,659 students in 2022 from 51,094 in 2013.

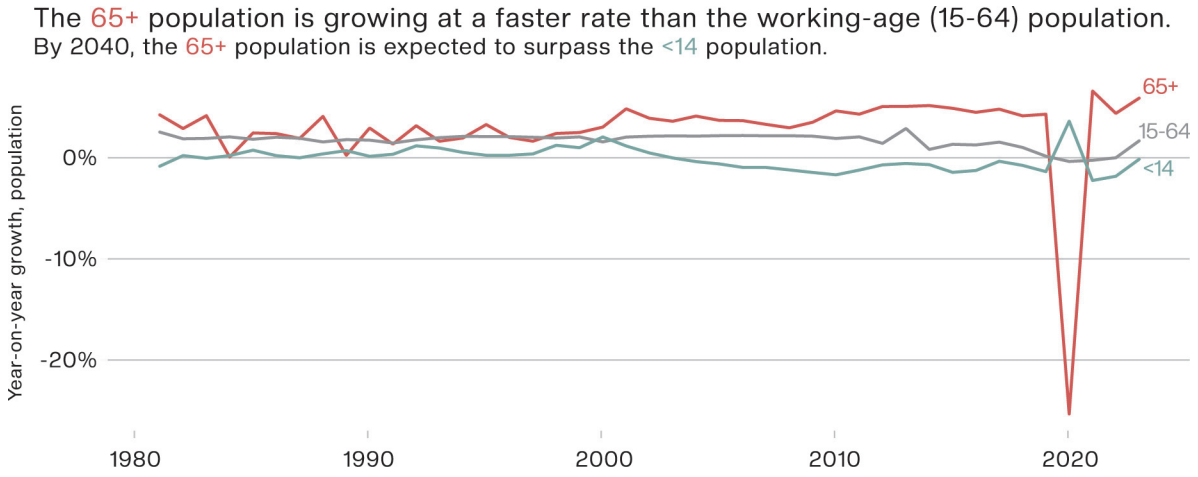
Shrinking share of engineering, manufacturing and construction intakes in Malaysian universities despite the increase in STEM intakes



5. **Demographic shift towards the old-age population and progressive migration policies in other countries**

Penang's workforce is undergoing a demographic shift. A workforce shortage is set to be caused by two reasons: low population growth and the progressive migration policies of other countries. In 2023, the state's overall population growth was 1.8%. While this is positive, it is important to note that the population segment aged 65 and over is increasing at a faster rate than the working-age population (15-64). By 2040, the old-age population is expected to surpass the young population aged 14 and below.

Figure 2.3: Penang's population growth by age cohorts from 1980-2023



Source: Key Penang Statistics, Penang Institute.

Meanwhile, migration is significant in Penang. For over a decade, Penang has experienced a positive migration ratio, except for 2020. According to the Department of Statistics Malaysia (DOSM)'s Migration Survey, Penang recorded its first negative migration effectiveness ratio of 8.3% in 2020[5]. Even though the net out-migration of about 1,400 people may be insignificant, it indicates the trend of people moving out of Penang.

Additionally, progressive migration initiatives undertaken by neighbouring countries lead to increasing emigration, especially by the top talents. For example, Singapore offers a five-year visa under the Overseas Networks and Expertise (ONE) pass for skilled foreign talent earning at least SGD30,000 annually. For individuals, there are various types of passes including EntrePass for foreign entrepreneurs, WorkPass for semi-skilled workers and

5 Due to high statistical uncertainty, the latest 2022's Migration Survey Report does not publish data for the selected states including Penang.

Personalised Employment Pass for high earners. For companies, there are Tech@SG for fast-growing companies with up to 10 new employment passes and Tech. Pass for established tech entrepreneurs, leaders and technical experts. As the top global hirer in Southeast Asia, Singaporean firms hire mostly for tech roles, such as Software Developers and Engineers, Account Executives and Managers (Sales), Graphic Designers, Accountants and Customer Support Staff.[6]

6. Shift towards the gig economy

The digital economy has reshaped the traditional work landscape through the rise of gig jobs. E-hailing, food delivery, e-commerce, and online services, including social influencers, have created vast job opportunities and unprecedented income sources. This shift has diverted the workforce from many mainstream industries, challenging the demand for conventional full-time employment and has led to a rise in demand for new and flexible work arrangements.

The talent shortage is intensified by the new employment landscape. Malaysians can now be hired to work locally in Malaysia for overseas and international companies.[7] Deel, a global people platform, reports that Malaysians are being hired worldwide as interpreters, statisticians, software engineers, virtual assistants and animators. For this form of hiring, workers have options to expand income sources by taking several jobs part-time. Regardless of the level of education, there is an increasing inclination among individuals to opt for longer part-time work hours.[8]

While there is a widespread mandate for the return to office, the global remote workforce continues to expand. The war for international top talent remains steadfast, leading to more

6 Human Resources Director (HRD, 2024). *Global hiring in APAC expands by 57%*. Retrieved from https://www.hcamag.com/asia/specialisation/recruitment/global-hiring-in-apac-expands-by-57/474842

7 New Straits Times (2024, Feb 19). More Malaysians opting for gig, global hiring work. *Business Times*. Retrieved from https://www.nst.com.my/business/economy/2024/02/1014995/more-malaysians-opting-gig-global-hiring-work

8 New Straits Times (2024, May 27). DoSM: More than a third of graduates are in semi-skilled, low-skilled jobs. *Business Times*. Retrieved from https://www.nst.com.my/business/corporate/2024/05/1055763/dosm-more-third-graduates-are-semi-skilled-low-skilled-jobs

options for the workforce. Due to the vibrancy of the new work regime, high demand for remote work, and more flexible terms, employers are taking steps to switch to part-time employees, which can reduce overall overhead expenses, especially on fringe benefits such as medical and insurance expenses.

2.2 Challenges to Building a STEM Talent Pipeline

Penang has consistently sustained high levels of investment in the technological-driven manufacturing sector due to investors' continued confidence in Penang's robust manufacturing supply chains. As the country becomes the destination of investment choice for E&E manufacturing activities, the current talent pool cannot fill the number of jobs the investments created. With NIMP 2030's focus being high-value-added manufacturing activities, it is imperative to address the overall STEM talent pipeline in detail and to increase the throughput from primary to tertiary education and beyond. Five key challenges have been identified in developing a STEM talent pipeline.

1. **Fragmented governance framework**

   The Ministry of Education targets 60% of students taking up STEM at the national level. The Malaysia Education Blueprint 2013-2025 seeks to increase students' interest through new learning approaches and through strengthening the curriculum, improving the skills and abilities of STEM teachers, and increasing awareness of STEM among students, parents, and the general public. Meanwhile, the Ministry of Science, Technology and Innovation (MOSTI), Natural Resources, Environment and Climate Change (NRECC), universities and external agencies also organise STEM enhancement activities. The unclear overarching governance has caused poor synergetic actions across ministries, agencies and industries, as highlighted in the National Science, Technology and Innovation Policy 2021-2030.

   In Penang, various initiatives by the Penang STEM centres should be lauded for nurturing and fostering STEM interest from early education to post-secondary. However, some initiatives and programmes appear to overlap across STEM centres, affecting the effectiveness of deliverables and resource allocation. In addition, the initiatives were not directly aligned

with the goal of increasing the number of students in science. There is a need to review and enhance the current initiatives as well as streamline them to ensure each of the agencies has clarity in their scope and end deliverables. It should be noted that there is also a lack of coordination between state and federal agencies to achieve the desired impact of STEM education programmes.

2. **Lack of STEM talent-building strategies for engineering and technology**

   Malaysia's electronics sector thrives in high-value activities like IC design and advanced packaging. However, many university programmes have not fully caught up to industry needs. Current bachelor's degrees in E&E and related disciplines offered by public and private universities, provide a solid foundation. However, these lack the specialisation needed for the higher value chain of engineering manufacturing. Furthermore, Malaysia's Higher Institution Centres of Excellence (HICoE) are not specifically available for technology and engineering (Appendix B).

   The absence of nationally or internationally recognised centres dedicated to specific engineering disciplines raises concerns for companies and investors. Scattering resources across universities creates a lack of clarity on graduate specialisation, potentially hindering confidence in Malaysia's talent pipeline for advanced technologies. This disconnect between industry demands and university offerings calls for immediate targeted action.

3. **Quantitative mismatch between demand and supply for STEM graduates**

   Penang faces a looming lack of engineers in the engineering and technology industry. A recent survey by Penang Institute (Penang Talent Prospects Survey 2023) indicates a significant demand for engineers (4,000) and technicians/machinists (3,700) by 2026 (Table 2.1).[9] This translates to a staggering 32% annual growth needed in engineers alone. However,

9 The survey received 62 complete and valid responses in March 2023, consisting of 39% Electronics & Electrical (E&E) companies, followed by 29% Machinery Equipment and 11% Semiconductors. While SMEs represented 75% of the sample, it is estimated that increased participations of large firms would provide a more complete picture of skill requirements.

university enrolment in engineering-related programmes has fallen considerably, creating a potential mismatch between supply and demand.

Table 2.1: Projected demand for talent in Penang

	2023	2026	CAGR[1]
Engineers	1,698	3,933	32.3%
Technicians/Machinists	1,935	3,737	24.5%
IT/software professionals	251	765	45.0%
IT technicians	86	217	36.1%
Total	**3,970**	**8,652**	**29.7%**

[1] Compounded annual growth rate
Source: Penang Talent Prospects Survey 2023, Penang Institute.

While 16 public universities in Malaysia offer E&E and related degrees and have less than 18,000 students enrolled in these disciplines, all universities experienced declining student enrolments from 2018 to 2022. The university with the highest enrolment for these disciplines was UNIMAP, followed by UTeM, UTM, UTHM and UMPSA. Each accounted for more than 2,000 enrolments. The rest of the universities enrolled less than 1,000 students yearly, including USM and UiTM, located in a state with the highest demand for engineering graduates.

Meanwhile, universities also recognise the challenges of filling the available capacity for engineering degrees. This may be due to the lack of interest among the young generation and a declining trend of science enrolment in public secondary schools. Given that Form 6 is the direct source of supply for university admission, the total number of science students plunged significantly by 82.2% (or 14.5% annually) from 2,138 students in 2013 to 381 students in 2023. Note that there are many other channels of study after secondary education, such as Foundation, Diploma and Matriculation.

4. Mismatch between competencies of university graduates and job requirements

The world of work is constantly changing due to technological advancements and automation. University curricula struggle to keep pace with these rapid changes, leaving graduates needing further upskilling/reskilling. While companies struggle to find qualified candidates, graduates with skills that do not match job requirements face difficulty finding employment, culminating in underemployment.

Although university/college education excels at transferring theoretical knowledge, some employers have expressed concerns that graduates lack the hands-on skills and knowledge necessary to apply the skills in real-world scenarios. A study by Penang Institute in 2022 reported that although engineering and computer science graduates rated skills learned in university to be somewhat relevant to current jobs, the rating was lower than in medical, dentistry and pharmacy, arts, communication, construction, accounting and finance and pure sciences.

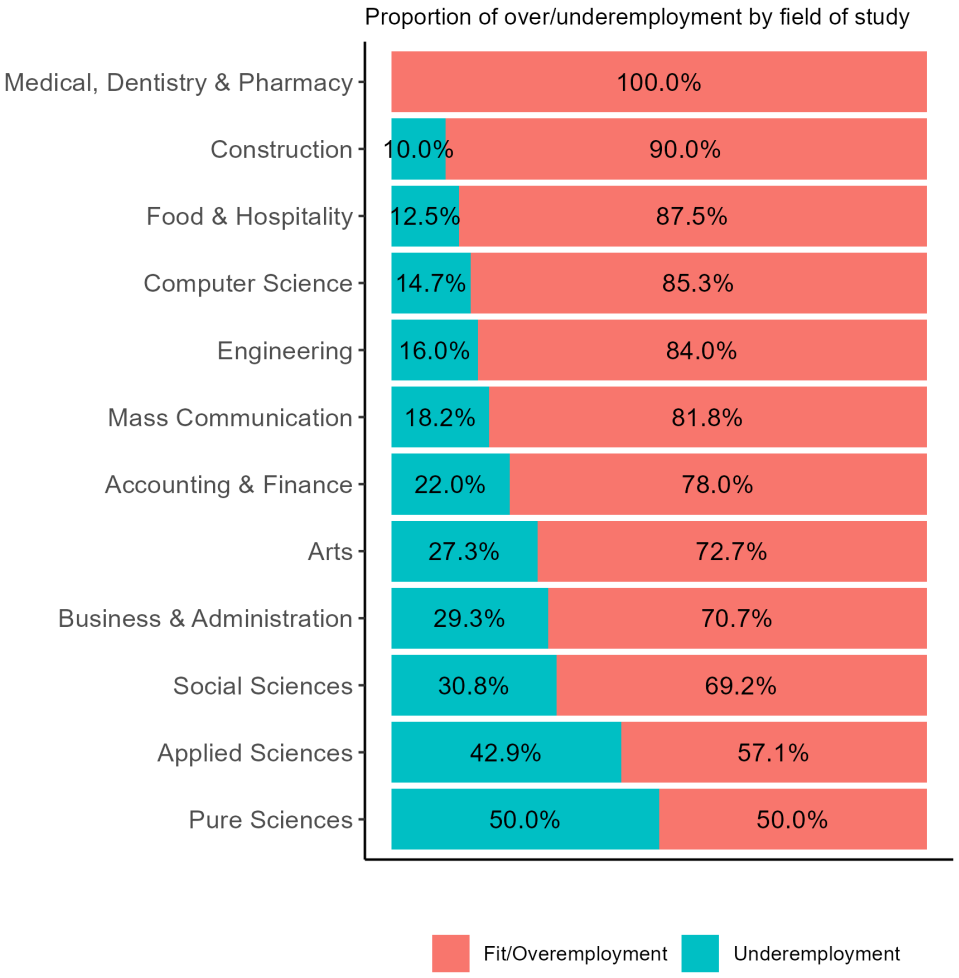
While most fresh graduates find jobs that match their education level, the survey revealed that 22.5% (68 out of 302 employed fresh graduates) are in a situation of skill-based underemployment. About 16% of engineering graduates reported skill-based underemployment. Notably, graduates from pure and applied sciences experienced underemployment rates of about 50% (Figure 2.4), in addition to their already low employment rates. This issue may stem from both a low supply of suitable jobs and a high number of graduates in these fields – a structural issue that needs to be addressed immediately.[10]

It is worrying to find that more than a third of employed graduates in Malaysia are in semi-skilled and low-skilled jobs, that focus on clerical support, sales and services, machine operators and assemblers and elementary jobs.[11]

10 Penang Institute (2022). A Study of Graduate Employability in Penang's Labour Market. *Reports*. Retrieved from https://penanginstitute.org/publications/reports-and-papers/reports/a-study-of-graduate-employability-in-penangs-labour-market/

11 New Straits Times (2024, May 27). DoSM: More than a third of graduates are in semi-skilled, low-skilled jobs. *Business Times.* Retrieved from https://www.nst.com.my/business/corporate/2024/05/1055763/dosm-more-third-graduates-are-semi-skilled-low-skilled-jobs

Figure 2.4: Percentage share of fresh graduates' skill-related underemployment by fields of study



Source: Penang Institute (2022). A Study of Graduate Employability in Penang's Labour Market. Available at https://penanginstitute.org/wp-content/uploads/2022/08/web_version.pdf

The lack of collaboration between industry and university encumbers the curation of programmes to accord with industry requirements. University research is mostly academically driven, and primarily focuses on paper publication. In Malaysia, joint research and co-patenting activities trail behind those in Singapore and Seoul. Despite a high share of Multinational Corporations (MNCs) contributing to increased originality, local research capabilities and the patent base remain weak.[12]

TVET programmes traditionally focus on practical skills, but there is now an opportunity to integrate analytical thinking and problem-solving into the curriculum. This will further strengthen the TVET programmes, making TVET graduates highly effective in executing tasks, maintaining equipment, identifying root causes and implementing solutions. Outcome-based competencies should be assessed in the TVET institutions and public and private universities. Whichever the case, Penang boasts the highest TVET graduate employability (GE) rate in Malaysia at an impressive 96.1% and the second-highest GE for university graduates at 92.4% in 2022.

5. Non-competitive compensation package

Penang's economic growth, fuelled by increasing capital investment, is leading to a talent shortage in engineering fields critical to the E&E industry. The shortage drives wage increases, with new companies offering higher salaries to attract skilled workers. While the wage growth may be gradual, it puts pressure on existing companies, both local and foreign, to retain their experienced workforce.

Based on the graduate employability survey done by Penang Institute (2022), STEM graduates earned an average monthly salary of RM3,022. This was considerably higher compared with the non-STEM cohorts at RM2,501. The average monthly salary for engineering graduates is

12 Wong, C. Y., Sheu, J., & Lee, K. (2023). Dynamics or Dilemma: Assessing the Innovation Systems of Three Satellite Platform Regions (Singapore, Dublin and Penang). Eurasian Geography and Economics, 64(5), 589–628. https://doi.org/10.1080/15387216.2022.2039741

estimated to be RM3,096, followed by computer science (CS) (RM2,985) and construction (RM2,702). This disparity reflects the high demand and limited supply of these skilled professionals in Penang's industrial landscape.

Despite this, informal observations suggest a potential talent gap in Malaysia's E&E sector due to factors like compensation packages in engineering professions potentially being less competitive compared to other fields. Additionally, factors external to compensation, such as the public image of engineering and technical professions, might play a role.

The weakening of Malaysia's Ringgit also plays a role in retaining skilled workers. According to a Department of Statistics Malaysia (DOSM) study, a substantial portion (66.7%) of Malaysians working in Singapore earn between S$1,500 and S$3,599 monthly (approximately RM4,800 - RM11,500) in 2022. The main reasons to work in Singapore were the job opportunities and suitable environment, higher salaries, and the high exchange rate, among other things.[13]

2.3 Opportunities: Target Growth Industries

Penang's economy thrives on the E&E industry, encompassing the entire value chain, from chip design (fabless/integrated design manufacturing) to final assembly and testing (back-end manufacturing, including advanced packaging, outsourced semiconductor assembly and test (OSAT), and equipment making).

Contributing over a third of the state's GDP and employing more than 230,000 workers, the E&E industry has spurred the growth of various supporting industries. These ancillary sectors benefit from the continued demand for machinery and equipment, scientific and measuring instruments, fabricated metal products, basic metal products, and non-metallic mineral products.

13 New Straits Times (2024, Feb 19). *DOSM: Most M'sians in S'pore, Bruneiare skilled, semi-skilled workers*. Retrieved from https://api.nst.com.my/news/nation/2024/02/1015101/dosm-most-msians-spore-brunei-are-skilled-semi-skilled-workers

Local companies play a crucial role in this ecosystem, providing complementary solutions in materials, components, parts, tools, and equipment to the E&E industry. Penang's semiconductor supply chain's influence and spillover effects extend beyond its borders, with Kulim Hi-Tech Park in Kedah focusing on front-end wafer fabrication and integrated circuit (IC) substrates. Additionally, software and embedded system solution vendors for IC design and electronic products have established themselves in Penang, fostering closer collaboration between designers and users.

This comprehensive network caters to the complexities of the global E&E supply chain, fostering a robust and sustainable ecosystem that solidifies Penang's position as a prime investment destination for the E&E sector in Malaysia.

The NIMP2030 has identified the priority sectors for growth: aerospace, chemical, E&E, machinery and equipment, and medical devices. Penang's industry strengths align with these target growth areas outlined in the NIMP2030 and the new National Strategic Sectors (NSS). Its E&E is an anchor industry for the "Silicon Valley of the East", focusing on high-value-added products and job creation. Beyond E&E, the strong growth spillover enables the proliferation of the supporting and ancillary ecosystem in machinery and equipment, automotive, medical devices and global business services. Table 2.1 summarises the target growth areas in Penang along with those for the NIMP 2030 and the NSS.

Table 2.1: Penang's target growth areas, NIMP2030 and NSS targets

Industries	Penang's target areas of growth	NIMP2030	NSS (as of 28 May 2024)
IC design	1. Position Penang as a globally renowned hub for IC design through the initiative of **Penang Silicon Design @5KM+** a. Build one million square feet of premium office space for **Integrated Circuit (IC) Design and Digital Park** to foster innovation and attract global and local investments in a vibrant ecosystem b. Develop Penang as a hub for **end-to-end semiconductor design development academies** (e.g. Penang Chip Design Academy) as part of talent cultivation programmes to upskill and reskill engineers c. Establish **Silicon Research and Incubation Space** as a one-stop centre for value-added services and shared facilities including incubation space, consultation, and research to help startups develop ideas and prepare for New Product Introduction (NPI)	1. Establish Malaysia as a global IC design champion in EV, RE and AI by scaling up five local IC design companies 2. Digitalise IP application and launch enhanced National IP Policy	1. Attract RM500 billion investments in IC design, advanced packaging and wafer fabrication 2. Establish 10 Malaysian companies in design and advanced packaging with revenues between RM1 billion and RM4.7 billion, and 100 semiconductor-related companies with RM1 billion revenue 3. Developing Malaysia as a global research and development (R&D) hub for semiconductors with world-class universities and corporate R&D 4. Train and upskill 60,000 high-skilled Malaysian engineers 5. Allocate at least RM25billion in fiscal support for targeted incentives

Industries	Penang's target areas of growth	NIMP2030	NSS (as of 28 May 2024)
Wafer fabrication		1. Attract new advanced wafer fabrication in Malaysia 2. Develop the capability of wafer fabrication by setting up local production of mid-tier (28-40nm) wafer fabrication by attracting global wafer fabrication leaders and expanding the capabilities of local companies	Refer to page 36.

Industries	Penang's target areas of growth	NIMP2030	NSS (as of 28 May 2024)
Machinery & equipment (M&E), IIoT solutions	1. Increase Penang's E&E ecosystem expertise in electronics, mechanics, precision tooling and metal fabrication 2. Penetrate into front-end equipment manufacturing 3. Scale up local automation solutions to serve Tier-1 multinational corporations (MNCs)	1. Build strong local SMEs in manufacturing and related services to support the industry champions 2. Expand into refurbishing services (e.g. industrial turbines and generators) and energy efficient solutions (e.g. water and wind turbines and photovoltaic power generating systems)	Refer to page 36.

Industries	Penang's target areas of growth	NIMP2030	NSS (as of 28 May 2024)
Medical technology (MedTech)	1. Position Penang as a MedTech hub for Asia 2. Acknowledge Penang's high concentration of MedTech companies in Malaysia and Southeast Asia, specialising in consumables, implants, surgical instruments, equipment and devices, and sterilisation 3. Enable the E&E supply chains in automation solutions and EMS	1. Identify high value-added opportunities i. Minimally invasive surgical tools ii. Implantable devices iii. Advanced inspection solution 2. Integrate value chains between i. M&E and Medical devices ii. E&E and Automotive iii. Chemicals & Pharmaceuti-cals	Refer to page 36.

Industries	Penang's target areas of growth	NIMP2030	NSS (as of 28 May 2024)
Other-related focuses	**Digital Global Business Services (DGBS)** 1. Position Penang as a high-value DGBS Hub 2. Boast the second-largest concentration of Malaysia Digital (MD) Status companies nationwide 3. Develop automation, connectivity and cloud services in the digital economy	**Specialty chemical vertical** Produce higher value-added intermediates and specialty chemicals in agro, care, nutrition, electronics* and construction **Advanced materials** Build Malaysian champions for advanced materials **Research, Development, Commercialisation and Innovation (RDCI) ecosystems** Assign specific topics and KPIs to universities for industrial-linked R&D	Refer to page 36.

Note: * Electronic chemicals are used in the production of electronic components such as semiconductors and PCBs e.g. silicon

FRAMEWORK: ROADMAP TO ENABLING A STEM TALENT PIPELINE

The model, strategy and action plan

3 FRAMEWORK: ROADMAP TO ENABLING A STEM TALENT PIPELINE

The model, strategy and action plan

3.1 The Model

A strong STEM talent pipeline requires immediate implementation of a comprehensive model to meet current and future industry needs. This Blueprint adopts a holistic framework integrating specific strategies from early education through post-tertiary education. Initiatives and programmes are proposed to accord with the objectives set for each value chain. This encompasses policymakers, educators, policy implementers, and private sector players.

Figure 3.1: Model for building a robust STEM talent pipeline

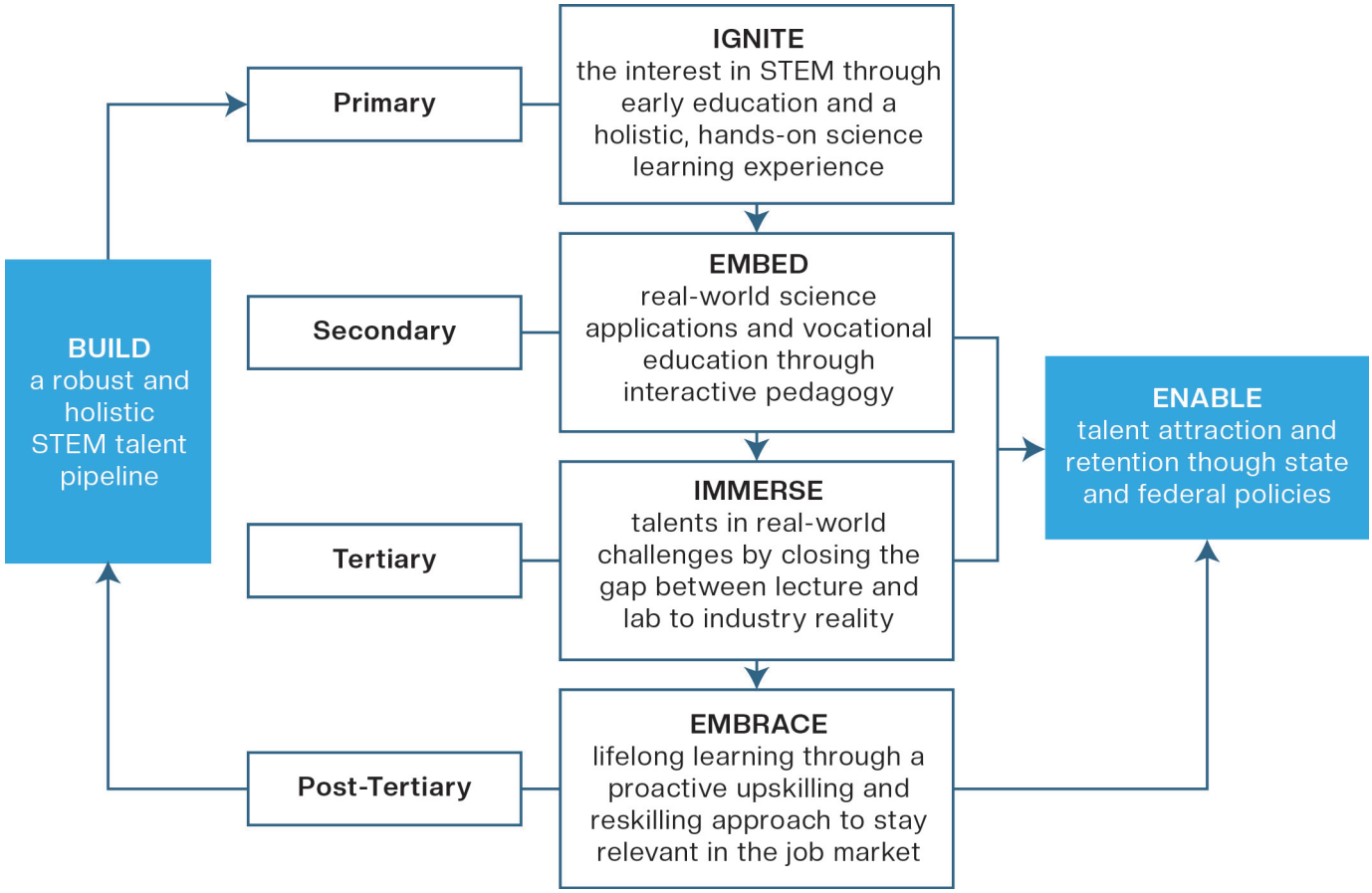


Figure 3.1 depicts the model the Penang state government aims to deploy to construct a robust and comprehensive STEM talent pipeline. The key elements for success are IGNITE, EMBED, IMMERSE, EMBRACE, and ENABLE. In primary schools, initiatives should focus on igniting interest in STEM and offering early exposure to science experiments through hands-on learning. In secondary education, the emphasis should be on embedding real-world science applications into science classes and offering vocational education to non-science students through interactive teaching methods.

To equip undergraduate students for joining the workforce, universities and colleges should provide immersive research experiences that reflect industry practices. Furthermore, with rapid technological advancements, employees must adopt lifelong learning, and utilise available resources to maintain relevance in the job market. This involves individual efforts and company-provided workplace training.

Policy reforms cutting across various disciplines with closed cross-ministries coordination and collaboration are urgently needed in building a sustainable talent pipeline for the country. Strong commitment from ministries is needed to streamline talent-friendly initiatives to resolve talent shortage and the mismatch of skills. The key ministries include but are not limited to:

- Ministry of Human Resources (MoHR)
- Ministry of Home Affairs (MoHA)
- Ministry of International Trade and Investment (MITI)
- Ministry of Education (MoE)
- Ministry of Higher Education (MoHE)
- Ministry of Finance (MoF)
- Ministry of Digital (MoD)

Talent-building policies play a major role in accelerating the country's economy and businesses' ability to create jobs, and in sustainable talent supply to meet the needs of companies over time.

The key targets of the model are as follows:

KEY TARGETS	MISSION: THRIVE
a. Double students' enrolments in STEM in secondary and tertiary education (including an increase of girls in STEM) b. Double university output of STEM graduates c. Designate engineering-specific universities to produce the right talents for the electronics/semiconductor industry d. Double STEM-related TVET output	**TRANSFORM** the education system
a. Leverage global talents by hiring fresh graduates from local universities & experienced foreign talent b. Increase positive migration effectiveness ratio and provide housing subsidies to ease mobility	**HIRING** of STEM talents
a. Reduce Malaysians working abroad b. Policy instruments with improved infrastructure and tax incentives	**RETAIN** talents in STEM
a. Increase funding to Penang STEM agencies for STEM programmes b. Increase funding to TVET institutions for upskilling/reskilling programmes c. Establish academies for End-to-End Semiconductor Design Development	**INVEST** in STEM education
Double the number of high-value jobs created	**VALUE** creation
Embrace a clear, consistent and cohesive governance framework across the STEM initiatives and resources	**ENABLE** governance framework

As alluded to by Prime Minister Anwar Ibrahim, the National Semiconductor Strategy (NSS)'s target of 60,000 engineers by 2030 requires a multi-pronged approach. This Blueprint proposes doubling the intake of science students in upper secondary schools. This target is needed to set the funnel for the intake of STEM-related programmes in higher education institutions. Likewise, this also calls for a corresponding increase in technicians and craftsmen trained through TVET programmes.

From the job creation perspective, the Penang state government aims to double the number of high-skilled jobs from the current average of 3,089 (2021-2023) to approximately 6,200 by 2030.[14]

With more high-value and high-skilled jobs created in Penang, the state aims to attract talent seeking a dynamic work environment and the opportunity to set roots in a vibrant location. Competitive salaries, such as the starting range of RM3,500-RM4,500 for engineers, are expected to reduce reliance on gig work and solidify Penang as a desirable place to work and live.

Table 3.1 outlines the projected need for 22,000 E&E, mechanical, and related engineers by 2030, requiring a compounded annual growth rate (CAGR) of 9% from universities. This translates to systematically increasing pure science enrollment in public upper secondary schools to 287,656 students in Malaysia. Penang sets to achieve about 18,800 pure science students or 70% of the entire upper-secondary students enrolling in STEM. Meanwhile, TVET output needs to reach 86,686 graduates in engineering, manufacturing and construction disciplines by 2030.

14 This includes managers, professionals, technicians and supervisors.

Table 3.1: Projections of the talent demand and supply indicators

Indicators	Baseline (2023)	Target outcome by 2030 (with policy interventions)
1. Double students' enrolments in pure science in public upper-secondary schools (Form 4 and 5)	Penang: 9,411 students (or 25.6% of total students) Malaysia: 143,828 students (or 19.5%) while 50.8% in STEM (2024)	Penang: 18,822 students (with 70% of total students in STEM) Malaysia: 287,656 students
2. Double students' enrolments in science and technology in public upper- secondary schools	Penang: 12,177 students (or 33% of total students) Malaysia: 69,796 students (or 28.9%)	Penang: 24,354 students Malaysia: 139,592 students
3. Double university output of STEM graduates	Malaysia: 11,168 graduates in E&E, Mechanical and related engineering (2022)	Malaysia: 22,336 graduates in E&E, Mechanical and related engineering, with a CAGR of 9%*
4. Double STEM-related TVET output	Malaysia: 43,343 graduates in Engineering, manufacturing and construction (2022)	Malaysia: 86,686 graduates in Engineering, manufacturing and construction, with a CAGR of 9.1%
5. Double the number of high-value jobs created	Penang: 3,089 high-skilled jobs created from approved manufacturing investments (an average from 2021-2023)	Penang: 6,177 high-skilled jobs to be created

Note: *Engineering intakes dropped by 22% from 2016-2022. Some percentage of graduates is expected to work in the non-E&E sector.
Source: Ministry of Education, Ministry of Higher Education, Malaysian Investment Development Authority

3.2 Strategy and Action Plan

The STEM talent pipeline, specifically for the high-tech manufacturing industry, involves four key elements:

i. Developing front-end STEM talent,
ii. Deepening tertiary STEM talent,
iii. Continuous learning in STEM, and
iv. Talent attraction through state and federal policies.

3.2.1 Developing Front-end STEM Talent

Strategy 1

Ignite interest in STEM and a holistic, hands-on science learning experience among primary school children

Strategic Outcomes

a. Increase the number of students taking part in programmes
b. Increase the number of visitors to Tech Dome Penang (TDP) by 20% annually
c. Attain 50% student satisfaction with the programmes

Enablers/Action Plan

i. State/federal funding for specific programmes to be included as co-curriculum and/or for curriculum embedment
ii. Lab enhancement in primary schools to support the programmes
iii. Tech Dome Penang to run in-house programmes

Type of Programmes

Structured programmes developed and executed by Penang Math Platform (PMP) and TDP

Strategy 2

Embed real-world science applications and vocational education through interactive pedagogy among secondary school children

Strategic Outcomes

a. Attain 50% of students expressing interest in science after the programmes
b. Double the number of students taking part in programmes
c. Double the number of students going into pure science
d. Target 70% of a minimum of 1,800 participants state-wide annually undertaking study-work module with the industry after the 2-year programme under Technical Skill Learning (TSL)

Enablers/Action Plan

i. State/federal funding for specific programmes to be included as co-curriculum and/or for curriculum embedment
ii. Lab enhancement in secondary schools to support the programmes
iii. Commit 5 years of funding for Technical Skill Learning (TSL)
iv. Organise "Meet the Makers" sessions where students interact with industry leaders
v. Invite industry professionals to showcase real-world applications of STEM concepts

Type of Programmes

Structured programmes developed and executed by Penang STEM, PMP and Penang Science Cluster (PSC).

3.2.2 Deepening Tertiary STEM Talent

Strategy 3

Immerse talents in real-world challenges by closing the gap between lecture and lab to industry reality

Strategic Outcomes

a. Double the number of students participating in engineering/technology vocational programmes
b. Double the number of graduates in technology/engineering programmes
c. Increase graduate employability for engineering/technology/science degrees
d. Increase the percentage of graduates perceiving job-skill relevancy by two times

Key Enabler

Federal government to identify 5-6 universities to increase graduate talent needs of the electronics/semiconductor industry

Enablers/Action Plan

1. Funding/grants
    a. Adopt a unified grants approach focused on TVET and increase funding (including allowance) for TVET students
    b. Increase funding for the universities to enhance capacity building
2. New specialisations and programmes
    a. Offer semiconductor technology, packaging technology, substrate engineering, IC design, and embedded software engineering programmes with industry immersion
    b. A FastTrack approval of new programmes (4-6 months)

3. Expertise in the Faculty
    a. Revamp the current sabbatical – focus on upskilling selected staff by secondment to the industry for no less than 6 months
    b. Import foreign professors to strengthen the university academic capabilities
    c. Secondment of experts from SMEs and selected companies to universities (no less than six months)
4. Pedagogical approach
    a. Leverage Augmented Reality (AR)/Virtual Reality (VR) and Digital Twins to enable real life and state of the technologies and processes to be integrated into the teaching – avoid high CAPEX by universities

Type of Programmes

1. Technical Vocational Programmes
    - Precision Machining Technology (PMT)
    - Industrial Automation Technology (IAT)
    - Quality Assurance Technology (QAT)
    - Information Technology (IT)
2. University Degree Programmes
    - Master in IC Design
    - E&E degree programme with specialisation in IC Design
    - Multidisciplinary programme for Semiconductor Technology
    - Degree in Substrate Material Engineering
    - Degree and Master in Embedded Software engineering
    - Multidisciplinary undergraduate programmes with Advanced Packaging Technology
    - Engineering programmes with AI and Data Analytics as core subjects

3.2.3 Continuous Learning in STEM

Strategy 4

Embrace lifelong learning through a proactive upskilling and reskilling approach

Enablers/Action Plan

1. Complement HRDC funding with a special funding mechanism for specific upskilling/reskilling programmes to enable lifelong learning:
   a. IC Design
   b. AI in manufacturing
   c. Analytics for manufacturing/Industry 4.0
2. Set up academies for End-to-End Semiconductor Design Development

Strategic Outcome

Increase the number of talents in IC design through Penang Chip Design Academy

Type of Programmes

As needed by the industry

3.2.4 State and Federal Policy Game Changers

Strategy 5

Enable talent attraction and retention through state and federal policies

MINISTRY OF FINANCE

Enablers/Action Plan

1. Incentivise STEM and TVET as education and career options through special tax treatment/tax relief for
   a. parents who send their children to TVET and engineering degree programmes
   b. parents whose children are in pure sciences in upper-secondary schools
   c. parents who send their children to accredited STEM-related classes e.g. Mathematics, coding, programming etc.
   d. individuals who invest in upskilling and reskilling in engineering and technology-related courses
2. Increase scholarship allocation for engineering and technology courses in colleges and universities through PTPTN
3. Offer partial/full subsidies to low-income families (B40) to help them afford STEM enrichment classes (e.g., mathematics, coding, programming, robotics) for their children

Strategic Outcomes

a. Encourage parents to inspire their children to enroll in the science stream in upper secondary schools and colleges
b. Increase the opportunity of STEM participation for B40 families
c. Reward companies in targeted growth industries that invest in upskilling and reskilling employees

MINISTRY OF HOME AFFAIRS AND TOURISM, ARTS AND CULTURE MINISTRY

Enablers/Action Plan

1. Open engineering and technology jobs to international graduates for up to five years (on a renewable basis)
2. Ease the talent visa approval system from other countries by providing a time-bound Professional Visit Pass (PVP) flexibility/Tech.Pass (Singapore)
3. Customise the requirements of Malaysia My Second Home (MM2H) packages to cater to foreign talents

Strategic Outcomes

a. Increase the hiring of foreign talents by enabling mobility in the country
b. Reduce talent shortage in the engineering and technology sector by hiring global talents, graduates from local universities, and experienced foreign talent
c. Increase positive in-migration effectiveness ratio

MINISTRY OF HUMAN RESOURCE

Enablers/Action Plan

1. A key driving force by opening up engineering and technology jobs to international graduates for up to five years (on a renewable basis) subject to the shortage of talents
2. Spearhead the ease of the talent visa approval system from other countries by providing a time-bound Professional Visit Pass (PVP) flexibility/Tech.Pass (Singapore)
3. Encourage corporate social investment in future workforce by allowing companies to claim from HRD Corp for contributions to approved STEM programmes and general contributions to Penang STEM centres
4. Set up a comprehensive registry of Malaysians working abroad to attract them back to their home country for highly sought-after jobs

Strategic Outcomes

a. Increase the hiring of foreign talents by enabling mobility in the country
b. Reduce talent shortage in the engineering and technology sector by hiring global talents, graduates from local universities, and experienced foreign talent
c. Increase positive in-migration effectiveness ratio
d. Increase corporate social contributions to aid local STEM centres
e. Attract Malaysians who work overseas to work in Malaysia

MINISTRY OF EDUCATION

Enablers/Action Plan

1. Work together with Penang STEM centres to fund the igniting programmes in pre-schools and primary schools
2. Adopt the latest technology in new teaching and learning methods
3. Work with foreign counterparts for tech education
4. Work with Ministry of Digital to digitalise classrooms for AI-powered interactive learning
5. Implement a programme to subsidise tuition fees for children from low-income families (B40) who enroll in STEM enrichment classes, such as Kangaroo Maths, Singapore Maths, coding, programming, robotics, and other relevant disciplines

Strategic Outcomes

Double science and technology students' enrolments in secondary education (including increasing the proportion of girls in STEM)

MINISTRY OF HIGHER EDUCATION

Enablers/Action Plan

1. Designate engineering-specific universities to increase the quantity and quality of graduate talent for the electronics/semiconductor industry
2. Develop specialised engineering programmes within universities, aligned with industry requirements for high-value sectors
3. Consolidate resources and expertise in selected universities to create nationally recognised centres of excellence for advanced engineering education
4. Assess outcome-based competencies in universities
5. Increase funding to TVET institutions
6. Rebrand TVET's public perception as a career choice with rewarding career opportunities
7. Focus on TVET in semiconductor technology to equip graduates with end-to-end skills

Strategic Outcomes

a. Double student intakes in STEM in tertiary education
b. Double university STEM output
c. Double STEM-related TVET output

MINISTRY OF INVESTMENT, TRADE AND INDUSTRY

Enablers/Action Plan

1. Introduce a policy allowing companies to claim full tax deductions for their donations to support national talent development in STEM fields including schools programmes and initiatives, STEM centres, and TSL
2. Integrate funding for STEM learning programmes and initiatives into the human capital development section of the National Science Strategy (NSS) e.g. academies for end-to-end semiconductor design development

Strategic Outcomes

a. Achieve the goals and targets set in the NIMP 2030 and the NSS

PENANG STATE GOVERNMENT

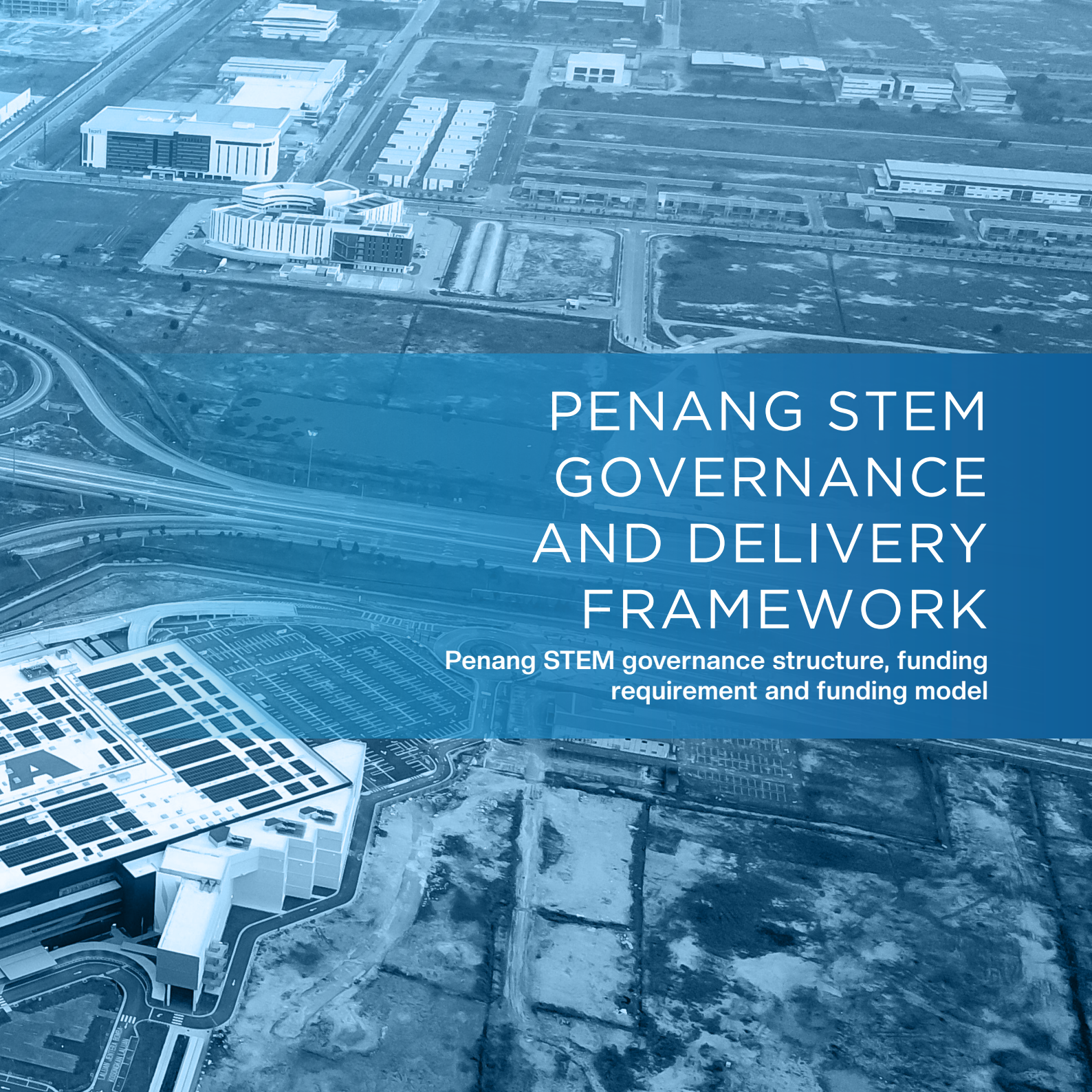
Enablers/Action Plan

1. Increase sustained fiscal funding to Penang STEM centres i.e. Tech Dome Penang, Penang Science Cluster and Penang Math Platform
2. Integrate funding requirements for Penang STEM centres as development expenditure within the state's annual budget application to the federal government
3. Work closely with companies to provide housing at a subsidised rate to employers who employ fresh graduates from other states
4. Set up and support academies for End-to-End Semiconductor Design Development in partnership with industry and train providers through federal-state co-financing
5. Promote education technology in Penang's tourism products and services e.g. Tech Dome Penang

Strategic Outcomes

a. Ensure sustained funding for the long-term operational viability of all Penang STEM centers
b. Solidify Tech Dome Penang's position as the premier science discovery centre for the northern region of Peninsular Malaysia
c. Retain and attract talents to work and build families in Penang
d. Extend upskilling and reskilling opportunities to equip the existing workforce with the cutting-edge skills demanded by the evolving engineering and technology industry


IKEA
IKEA



PENANG STEM GOVERNANCE AND DELIVERY FRAMEWORK

Penang STEM governance structure, funding requirement and funding model

4 PENANG STEM GOVERNANCE AND DELIVERY FRAMEWORK

Penang STEM governance structure, funding requirement and funding model

Penang forges a collaborative STEM learning and education ecosystem. To achieve the ambitious goals, a clear and coordinated governance framework is necessary to create a STEM talent pipeline and promote continuous skills development to meet Penang's talent needs.

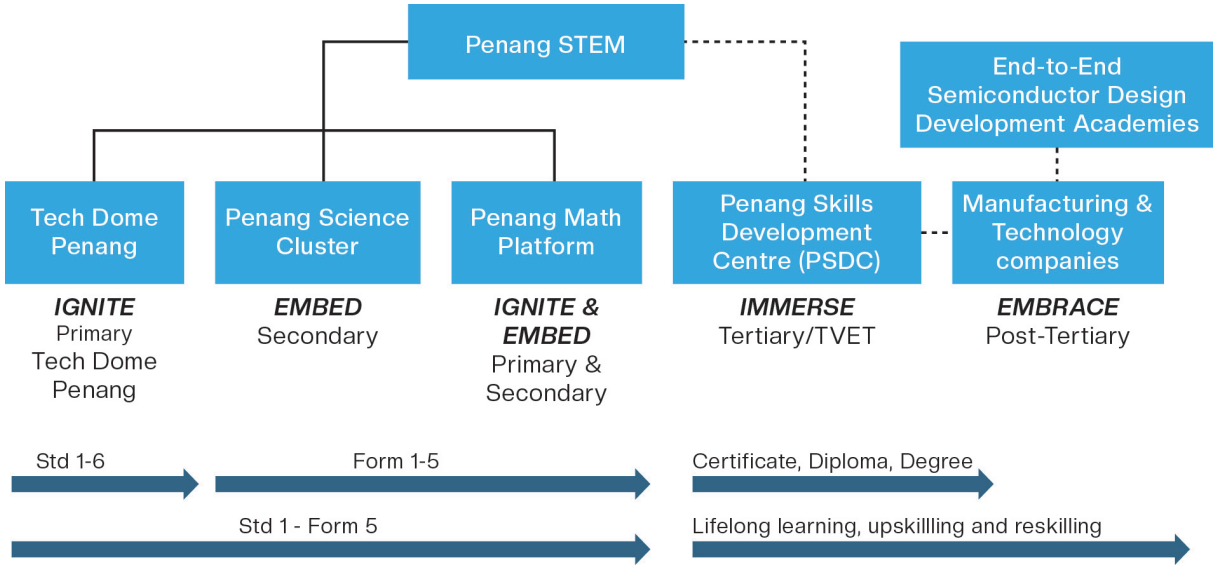
4.1 Penang STEM Governance Structure

Building a sustainable STEM talent pipeline hinges on concerted, coordinated, and continuous collaboration efforts in cultivating STEM interests from a young age. It must start from pre-school and continue through to tertiary education. After entering the workforce, lifelong learning should continue, either through self-learning or company-provided skill training, to stay relevant to current market requirements.

The Penang government has proactively ensured that STEM interest among primary and secondary school students is encouraged. Despite this, recent data shows a decrease in the number of students choosing the Science stream. Therefore, a robust governance structure is needed for effective programme delivery and efficient use of resources.

The Penang government recognises the need for a streamlined governance structure that uses a collaborative and cohesive approach to enhance STEM education. Figure 4.1 illustrates how each STEM centre implements programs and initiatives guided by the IGNITE, EMBED, IMMERSE, and EMBRACE frameworks. It begins with a focus on primary school (Standard 1-6) by TDP, followed by secondary school (Form 1-5) by PSC, tertiary education or TVET for certificates, diplomas, and degrees undertaken by IHLs and TVET institutions, and post-tertiary through companies. PMP offers mathematics and mathematical sciences programmes at all education levels. Meanwhile, industry-driven end-to-end semiconductor design development academies will be available to close the specific skills gap needed by the industry.

Figure 4.1: Penang STEM Governance Structure



The structure prioritises close collaboration with schools, universities, and industry partners, aiming to cultivate a robust pipeline of highly skilled STEM professionals to continue propelling Penang's thriving engineering and technology sector. It emphasises a well-defined educational pathway, with each STEM learning centre – Tech Dome Penang (TDP), Penang Science Cluster (PSC), and Penang Math Platform (PMP) – playing a distinct role.

The initiatives and programmes by TDP, PSC, and PMP complement the existing science and mathematics curriculum offered in schools and universities. These centres equip students with cutting-edge foundational knowledge and practical applications of STEM subjects, potentially igniting their passion for STEM.

To build on the success of these existing programmes, the Penang STEM governance needs to **implement and monitor a set of outcome-based KPIs**. These KPIs will track the effectiveness of the initiatives delivery and identify areas for improvement to ensure efficient resource allocation. **This framework can be a blueprint for nationwide replication if it proves to have a positive impact on the STEM learning ecosystem.**

4.1.1 The Synergistic Roles of Penang STEM Centres

Penang STEM centres work collaboratively to create a comprehensive and future-oriented approach to STEM education. They function as a cohesive network, equipping students with the necessary skills to excel in the technological age.

As a collaborative hub for nurturing future tech leaders, Penang STEM will continue acting as a central hub, coordinating programmes implemented by various STEM centres across Penang. The state-funded organisation initiates the development of large-scale STEM pipeline programmes for diverse student needs, with STEM centres being the programme delivery partners. It lays the groundwork of the programmes in partnerships with ministries, schools, institutes of higher learning (IHLs), technical training institutes, and industry partners.

Under the new governance structure, Penang STEM will strategically assign programmes to the most suitable STEM centres – TDP, PSC, and PMP – based on the Penang STEM model detailed in Section 3.1. All programmes and initiatives implemented by these centres are set to be anchored around the **IGNITE, EMBED, IMMERSE** and **EMBRACE** framework. The specific roles played by each STEM centre are described in Appendix C.

4.1.2 Academies for End-to-End Semiconductor Design Development

Given the growing demand for chip design engineers and the rise of AI, upskilling Penang's existing workforce in the IC (chip) design and AI sector is essential. In the short-to-medium term, this initiative will strategically foster high-paying jobs and enhance Penang's attractiveness as a hub for leading chip design and digital businesses. In the short-to-medium term, this ecosystem is envisaged to position Penang as a preferred destination for Tier-1 chip design investments.

To facilitate this, the Penang state government has designated a one-million-square-foot development for IC Design and Digital Park in Bayan Lepas Industrial Park. The park offers premium office space for companies involved in IC design, R&D, global business services, digital technology investments (including AI) and a circular digital economy. The first phase is scheduled to be ready in the fourth quarter of 2024, and the second phase by 2027, at a total cost of RM655 million.

Penang is uniquely positioned to cultivate Malaysian IC design champions. It boasts over 30 years of experience in semiconductor design and development, fostering a robust ecosystem with established industry giants like Intel, AMD, and Infineon. This solid semiconductor design journey translates to a skilled workforce capable of handling the entire chip design and development process, including high-frequency intellectual property (IP). Penang's strength lies not only in its digital and analogue design prowess but also in its established IC packaging and testing expertise. This comprehensive capability allows Penang to tackle even the most intricate IP and chip designs. This strategic initiative aligns with Mission 1 of the NIMP 2030 framework, aimed at cultivating Malaysian IC design champions.

Penang Chip Design Academy: Bridging the Gap in Chip Design Talent

The Penang Chip Design Academy (PCDA) has been set up to tackle the increasing demand for skilled design and development engineers in the semiconductor industry. Led by PSDC, it functions as a platform for industry veterans to be trainers for chip design courses; it curates industry-certified training courses and materials in collaboration with the industry and premier Electronic Design Automation (EDA) tools vendor(s); and offers infrastructure and EDA tools licenses for the training programme. Essentially, it is a Centre of Excellence enhancing chip design talents through chip design courses and is part of an R&D ecosystem involving university and industry partners.

PCDA complements the Collaborative Microelectronics Design Excellence Centre (CEDEC) at USM which focuses primarily on postgraduate courses and research while PCDA will place emphasis on training fresh graduate engineers from E&E and related degree programmes, and working professionals in E&E-related functions for IC design companies.

The Academy is guided by a distinguished advisory committee comprised of industry veterans with extensive experience in design and development. This committee will collaborate closely with industry partners such as foundry services, technical advisors and consultants across Malaysia to provide trainers/lecturers, and establish infrastructure, tools and licenses and training materials. This initiative sets out to enable the expansion of existing chip design companies, attract new foreign investment into Malaysia's IC design and R&D, and align with Malaysia's NIMP for moving up the semiconductor value chain.

Penang AI Academy: Revolutionising chip making

AI, as an enabler, continues to revolutionise the end-to-end semiconductor industry by optimising every stage of the production process. From initial design and simulation to manufacturing and quality control, AI algorithms can analyse vast amounts of data to identify inefficiencies, predict equipment failures, and enhance yield rates. In the design phase, AI accelerates the creation of complex chip architectures by automating layout generation and optimising performance parameters. During manufacturing, AI-driven predictive maintenance and process optimisation reduce downtime and

improve precision. In quality control, machine learning models identify defects with higher accuracy than traditional methods, ensuring that only the highest quality products reach the market.

In recent months, Generative AI has become the transformation leap within AI. Generative AI, a subset of AI, specifically focuses on creating new content, such as images, text and even video that resembles human-generated content. Generative AI uses models that learn from large data sets to generate new data and information. MNCs are already embarking on the use of Generative AI technology, creating their own proprietary Large Language Models (LLMs) models to provide solutions faster and with better quality in specific areas.

As part of the end-to-end semiconductor academy, it is proposed that an academy focusing on AI-powered end-to-end semiconductor design, development and manufacturing. This academy is created to upskill talents and enable them to apply and/or implement AI solutions and technologies for faster development cycles, reduced costs and superior product quality.

4.2 Funding Requirements

A sustainable resource allocation is important to ensure Penang STEM and its affiliated centres to achieve the best outcome in programme delivery. A tripartite funding approach is taken into consideration to support this goal. The state government is anticipated to support the operating expenses of the STEM centres. Meanwhile the federal government through various ministries is suggested to finance large impact programmes, including capital expenses of the science discovery centre (or TDP).

To ensure the successful achievement of programme outcomes at its three centers, a consistent tripartite funding model is proposed. Under this model, the federal government would contribute the majority share (55.6%), followed by the state government (31%) and industry partners (13.4%), with a total requirement of RM49.5 million.

About 72.5% (or RM35.9 million) is required by Penang STEM centres, where the Blueprint proposes the federal government allocating RM17.6 million (or 48.8% of the required funds) annually, while the state government contributes to share RM11.7 million (or 32.7%). The remaining 27.5% (or RM13.6 million) is required for Penang Future Foundation and TVET programmes.

The sponsorships from industry partners will primarily be programme-based and targeted to expose and train students with specific skills. This takes up about RM6.7 million annually (or 18.5%). Table 4.1 details the operating and capital expenditure of the state government, federal government and industry.

Table 4.1: Estimated annual funding requirements for the STEM centres in Penang (RM '000)

Penang STEM Centres	Type of Expenses (RM)	State		Federal		Industry	TOTAL	
		CAPEX	OPEX	CAPEX	OPEX	OPEX	CAPEX	OPEX
Penang STEM	Non-programme		230					230
	Programme*				10,800			10,800
Tech Dome Penang	Non-programme**	5,950	4,572	5,950			11,900	4,572
	Programme					2,111		2,111
Penang Science Cluster	Non-programme		400					400
	Programme				800	4,000		4,800
Penang Math Platform	Non-programme		590					590
	Programme					545		545
TOTAL		5,950	5,792	5,950	11,600	6,656	11,900	24,048
GRAND TOTAL			11,742		17,550	6,656		35,948
% share			32.7%		48.8%	18.5%		100.0%

Note:
*Include three programmes: Technical Skill Learning (MITI), StepUP WizKids (MOSTI) and STEM Future-Proofing (RMK-12).
** Non-programme expenses include cost for operation, gallery/exhibition refurbishments, infrastructure upgrades, tools and equipment for workshops and maintenance. These are one-time expenses.

4.2.1 Penang STEM: A Catalyst for a Thriving STEM Ecosystem

Penang STEM ignites a passion for STEM in students across all academic levels through three targeted programmes: StepUP: Wizkids caters to lower secondary students; STEM Future-Proofing (SFP) prepares academically strong upper-secondary students with exposure to ICT and engineering courses in colleges, and Technical Skill Learning (TSL) empowers students in Form 4 and 5 who may not be as academically inclined by providing them with practical, hands-on STEM training. These programmes along with the programme delivery partners and the specific fund's proposals are illustrated in Figure 4.2 and Table 4.2 elaborates on the details and strategic outcomes of each programme.

Figure 4.2: Penang STEM's initiatives

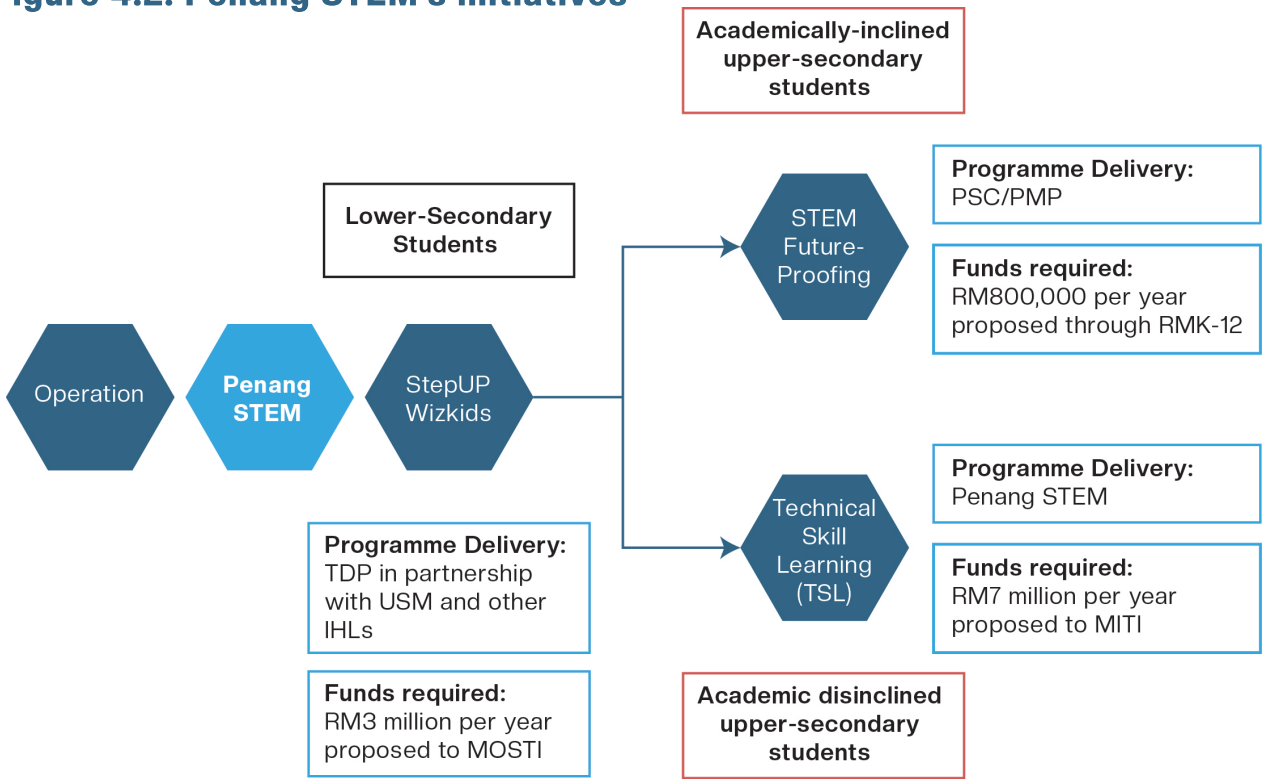


Table 4.2: Penang STEM initiated programmes

StepUP: WizKids	STEM Future-Proofing (SFP)	Technical Skill Learning (TSL)
StepUP is the second series of introductory programmes designed to spark curiosity and ignite a passion for STEM among lower secondary students. It introduces students to coding, programming and fundamental mathematical sciences learning. These are foundational skills for Artificial Intelligence (AI) and other cutting-edge fields. **Strategic outcome:** The programme aims for 70% of participating students to opt for STEM streams by the end of a five-year pilot by 2029, benefitting 1,200-3,600 students per year.	Penang STEM has also initiated SFP, which will be conducted in schools by lecturers from private colleges to lay the foundation for students to continue with studies in diploma or degree programmes in Engineering and Computer Science. **Strategic outcome:** The programme targets to achieve 70% of participating students enrolling in STEM-related courses after completing secondary school, affecting 500-800 students annually.	Accredited by the Skills Development Centre (Jabatan Pembangunan Kemahiran) under the Ministry of Human Resources, TSL is a programme to empower upper-secondary students who are academically less inclined by providing foundation training in technical and vocational skills. The programme will integrate into the existing curriculum as an extracurricular for upper secondary schools (Forms 4 and 5) to minimise disruption to students' regular studies. Based on the National Occupational Skills Standards (NOSS), students are given opportunities to pursue higher-level skills certifications in post-secondary institutions under the Work-Study system (Sistem Latihan Dual Nasional (SLDN)) programme. **Strategic outcome:** The programme targets to achieve 70% of participating students seamlessly transitioning into a Work-Study programme or enrolling in full-time higher-level TVET courses after completing secondary school, benefiting 1,800-2,500 students annually.

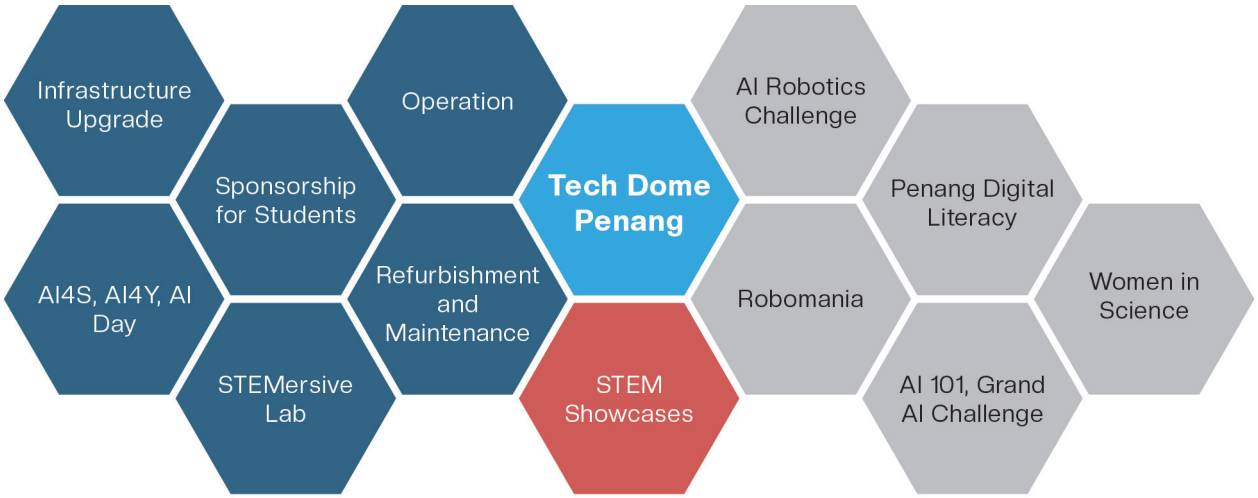
4.2.2 Tech Dome Penang: Igniting a Passion for Science and Technology

TDP targets to increase the number of children visitors by 20% annually through 2030. The in-house workshops and competitions will benefit more than 5,000 students. The programmes also aim to achieve more than 50% satisfaction rate among the participants' post-visit.

TDP requires an ongoing investment to maintain its infrastructure and exhibition spaces. To ensure its sustainability, a proposed funding model allocates capital-intensive costs equally between the state and federal government (Figure 4.3). This ensures the long-term upkeep of the physical facilities. Meanwhile, programme development and execution within the TDP will be supported by industry partners. Their financial contributions will directly support the creation and delivery of engaging content for visitors.

The state government will take full responsibility for operational costs, encompassing day-to-day expenses required to run the TDP effectively. This multi-pronged funding approach ensures a collaborative effort to maintain and develop the TDP's initiatives, solidifying its position as a leading science and technology showcase.

Figure 4.3: TDP's initiatives and required funds



State/fed funds: RM11.9 million (CAPEX), RM4.6 million per year (OPEX)

Other sources funds: RM2.1 million per year (OPEX)

Flagship event with various sources

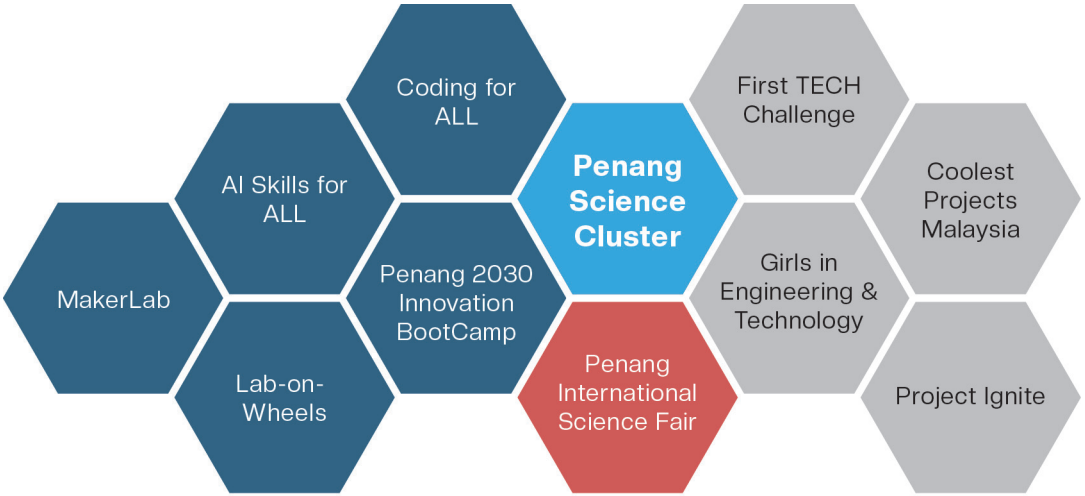
4.2.3 Penang Science Cluster: Embedding Innovation in Young Minds

As a state-linked company working closely with schools on science and technology programmes, PSC aims to significantly increase student participation and interest in pure sciences and computer science. The programmes target 500-20,000 Penang secondary students annually through engaging boot camps, competitions and workshops. With an ambitious goal, PSC aims to achieve KPIs as follows.

- 50% of students expressed interest in science after attending programmes
- 50% of students express intent to pursue pure sciences or technology stream after attending programmes
- Increase the share of students going into pure sciences and technology streams from 33% to 50%

PSC allocates RM4.8 million annually for programme delivery. It is expected that approximately 17% (RM800,000) of this budget will come from the federal government, with the remaining 83% (RM4 million) estimated to be secured from industry leaders and foundations (Figure 4.4). These programmes primarily target secondary school students. PSC strengthens STEM initiatives across Penang by collaborating closely with industry partners to develop structured programmes. Meanwhile, the state government allocates RM400,000 for the operating expenses.

Figure 4.4: PSC's selected programmes and required funds



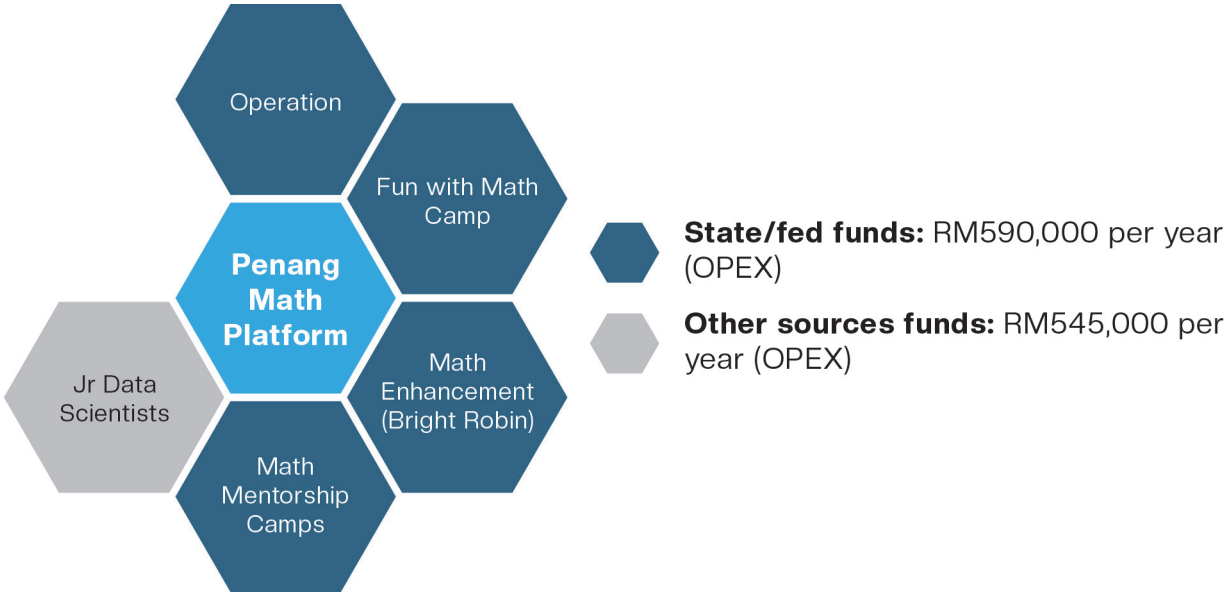
4.2.4 Penang Math Platform: Unleashing Mathematical Potential

Apart from mathematics and mathematical sciences classes, PMP also conducts workshops and programmes on Math-related activities including math competitions, seminars, workshops and Math camps for all age groups of students. Some of the significant ones include Singapore Bar Model Method Workshop, Rubik's Cube Workshop, Higher Order Thinking Skills (HOTS) Math

Challenge and so on. PMP's programmes target to benefit at least 500 students annually from primary and secondary schools, respectively to participate in camps, competitions and workshops. After attending the programmes, PMP hopes to achieve at least half of the participating students expressing interest in Math.

Penang STEM programmes require an annual budget of RM1.1 million. The state government generously allocates over half of this amount (52%), with industry partners contributing the remaining 48% (Figure 4.5).

Figure 4.5: PMP's selected programmes and required funds



4.3 Other Talent Retention and Development Initiatives

The state moots for a shared funding model between public and private sectors enhancing the STEM talent pipeline and ecosystem. Given limited jurisdiction, the state has identified the key programmes through which it can support the national agenda of achieving 60,000 engineers by 2030. The state will continue funding the existing programme: Penang Future Foundation; and PSDC and other TVET institutions will continue to drive the TVET programmes along with other academically inclined diploma and degree programmes. Meanwhile, new end-to-end semiconductor design development academies specifically in chip design and artificial intelligence (AI) will be the next pioneer programmes to build a ready talent pipeline.

4.3.1 Penang Future Foundation Scholarship: Cultivating Penang's Future Talent

Penang Future Foundation (PFF), made possible by donations from the private sector and individuals, is a scholarship programme awarded by the Penang State Government to outstanding and deserving Malaysians to pursue their undergraduate studies in Malaysia. This is one of the State's initiatives to stem the brain drain, and nurture Penang as a talent hub. While the scholarships are open to all eligible Malaysians regardless of race, religion and gender, preference is given to outstanding and deserving youths from single, low to middle-income families. Upon successful completion of studies, the sponsored scholars must work in Penang in organisations of their choice, be it in the private or public sector.

PFF has two scholarship programmes: Penang Scholar and Mutiara Scholar. The eligibility criteria for Penang Scholar and Mutiara Scholar are as follows:

PFF ELIGIBILITY CRITERIA

PENANG SCHOLAR

- **Eligibility to apply**
  - ✓ Minimum CGPA 3.67
  - ✓ Household income not more than RM15,000 per month (or annual gross household income of RM180,000)
- **Award**
  - ✓ Tuition fee up to a maximum of RM100,000
  - ✓ Monthly living allowance of RM800
- **Academic performance monitoring**
  - ✓ Maintain CGPA not less than 3.33

MUTIARA SCHOLAR

- **Eligibility to apply**
  - ✓ Minimum CGPA 3.00
  - ✓ Household income not more than RM5,000 per month (or annual gross household income of RM60,000)
- **Award**
  - ✓ Tuition fee up to a maximum of RM60,000
  - ✓ Monthly living allowance of RM500
- **Academic performance monitoring**
  - ✓ Maintain CGPA not less than 3.00

- Malaysian 25 years old or younger
- Entering university or currently studying at university
- Sponsored courses: MQA-accredited courses in STEM (exclude Medicine)
- Subject to the amount of sponsorship, graduated scholars are to work in any organisation of their own choice either in the private or public sector in Penang
- Bond period calculated based on the value of tuition fee and living allowance sponsored; one year of service for every RM20,000 (with a minimum one-year service bond up to a maximum of eight years)

Since 2015, the scholarship programme has awarded a total of 751 scholarships. It supports approximately 60 outstanding students in each intake, giving each a generous RM60,000 in support. Notably, 80% of these scholarships go towards studies in Engineering, Science, Technology, and Mathematics (STEM), with the remaining 20% supporting students pursuing degrees in Accounting and Finance. From 2025 to 2030, about RM21.6 million (or RM3.6 million) annually) are required to finance a maximum of 60 scholars per intake.

4.3.2 Penang Chip Design Academy: Building a World-Class Chip Design Workforce

Establishing a long-term, self-sustaining IC design training academy is crucial for Penang to be a centre of choice for IC design companies. The Academy's long-term viability can be ensured through co-funding opportunities, guest lectures and industry mentorship, government grants and a tiered fee structure catering to individual students/graduates and corporate training programmes. The PCDA aims to:

a. Collaborate with industry partners to design training modules that align with current and future industry needs and best practices
b. Form strategic partnerships with EDA tools vendor(s) for competitive licensing pricing models used in training programmes
c. Leverage PSDC's existing training facilities and expertise in delivering high-quality training programmes

PCDA has a comprehensive five-year plan (2025-2029) as presented in Table 4.3.

Table 4.3: Five-year plan for PCDA

Building a talent pipeline (2025-2029)	Incubation and growth (2025-2029)	Expanding the ecosystem (2026-2029)
This initiative focuses on rapid talent development through an industry-focused training programme. The programme aims to train 100 fresh graduates annually, expanding Penang's pool of skilled chip design professionals. PCDA will continue to work with the industry to design and develop additional programmes for IC design professionals and working professionals in E&E-related functions to hone their capabilities further and increase the IC design talent pool.	This initiative focuses on long-term sustainability. The Academy will explore the development of an incubation lab to nurture local IC design start-ups.	This initiative emphasises collaboration with universities to integrate the Academy's training programmes into existing educational pathways in the second year of E&E-related degree programmes. PCDA will collaborate with CEDEC, which currently acts as a gateway for IC design discipline to universities in Malaysia. This will further strengthen the overall talent development ecosystem nationally.

The Academy's initial establishment will require approximately RM3.4 million in capital expenses. To ensure long-term sustainability, a matching fund model between the government and private sector is proposed. The government's contribution is the initial funding to demonstrate its commitment to the Academy's success.

Leading IC design companies are invited to co-fund the Academy in exchange for benefits such as curriculum development collaboration, early access to a skilled local talent pool of design engineers and potential recruitment opportunities.

The first phase of PCDA is to train talents to meet the industry's needs. To be industry-ready, the training programme would take approximately three months to complete for fresh graduate engineers. To train and place graduates who are unemployed and have basic qualifications to embark on a career in IC design, it is anticipated that PCDA would require government funding of approximately RM2.3 million to train 100 engineers every year. In summary, a total of RM11.5 million is needed to train 500 engineers over the next five years.

This initiative is funded as part of the Penang Silicon Design @5KM+ initiative under the state government.

4.3.3 TVET programmes: Bridging the Gap between Education and Industry

Penang thrives on its technical talent pool, and its TVET institutions offer programmes aligned with industry requirements. Below are the top three programmes most useful to Penang's E&E sector:

- Precision Machining Technology (PMT): This equips students with the practical skills and knowledge needed to operate CNC machining tools and plan machining processes. It is offered at both certificate (Level 2 & 3) and diploma levels (Manufacturing Technology Level 4 and Manufacturing Technology (CAD/CAM) - Part-Time).

- Industrial Automation Technology (IAT): This caters to students interested in automation systems. It provides them with the knowledge to create 2D & 3D sketches, and prepare fabrication and sub-assembly requirements. Additionally, the programme offers training in Robotics, Industrial Automation (PLC), Electrical Systems, Electronic Systems (communication, power &

control), Hydraulic & Pneumatic Systems, and ICT facilities. Similar to PMT, IAT is available at both certificate (Level 2 & 3) and diploma levels (Industrial Automation Technology Level 4 and Automation Technology - Part Time).

- Quality Assurance Technology (QAT): This focuses on quality control within manufacturing processes. Students gain fundamental knowledge of inspection procedures, proper handling of tools and equipment, and essential manufacturing control processes. They also learn about quality systems and procedures that ensure production efficiency through testing and maintenance. QAT is offered at the certificate level (Level 2 & 3) and diploma level (Quality Assurance Technology (Metrology) Level 4).

By providing these industry-aligned programmes, TVET institutions play a crucial role in equipping Penang's workforce with the skills needed to excel in the E&E sector.

Penang Skills Development Centre (PSDC) offers both certificate and diploma levels in these programmes. To meet demand, about 3,000 technicians need to be trained from 2024, with an incremental increase of 500 technicians yearly. It is estimated that training an additional 2,500 TVET graduates will require funding of RM60 million from 2025 to 2030 (or RM10 million). This amount accounts for a training cost of RM24,000 per student for 2.5 years.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APPENDIX

A. STEM Packages in upper-secondary schools

According to the Ministry of Education, STEM packages are divided into three categories, with Option A covering the pure science subjects; Option B covering any two pure science subjects and Additional Maths; and Option C comprising none of the pure science subjects but at least two applied science and technology subjects or one vocational subject, as illustrated in Table A.2.

Table A.1: Available STEM packages in Malaysia's upper secondary education

Option	STEM electives	Core	Compulsory
Option A	Physics, Chemistry, Biology and Additional Maths	Bahasa Melayu	Physical and Health Education
		English	
		Mathematics	
		History	
		Islamic Studies/Moral education	
Option B	Any two pure science subjects and Additional Maths PLUS one STEM elective OR non-STEM elective	Bahasa Melayu	Physical and Health Education
		English	
		Mathematics	
		History	
		Islamic Studies/Moral education	
Option C	At least two applied science and technology subjects or one vocational subject	Bahasa Melayu	Physical and Health Education
	Note: Students taking the Additional Science elective are not allowed to take any pure science subjects.	English	
		Mathematics	
		History	
		Islamic Studies/Moral education	
		Science	

Table A.2: Available STEM elective subjects

STEM electives			
Pure science	**Applied science and technology**	**Vocational subjects**	
Physics	Additional science	Signage design & production	Geriatrics & basic gerontology
Chemistry	Technical graphics communication	Interior design	Domestic wiring
Biology	Sustainability basics	Domestic pipe work	Domestic electrical equipment repair
Additional Maths	Agriculture	Domestic construction	Automobile service & repair
	Home science	Furniture manufacturing	Arc & gas welding
	Design	Graphic design	Motorcycle service & repair
	Computer science	Multimedia production	Air-conditioning equipment service & repair
	Sports science	Catering & food service	Landscape & Nursery
	Civil engineering studies	Food processing	Crop planting
	Mechanical engineering studies	Dress designing & tailoring	Aquaculture & recreational pets
	Electrical & electronics engineering studies	Skin care & hair styling	
	Engineering drawing	Early childhood education	

B. List of Higher Institutions of Centre of Excellence (HICoE)

Malaysia's Higher Institutions of Centre of Excellence (HICoE) focuses on biomedical, renewable energy, clinical, agriculture and marine. Table B presents the types of HICoE available in Malaysian universities from 2010-2022.

Table B.1: List of Higher Institutions of Centre of Excellence in Malaysia

BATCH 1 2010	BATCH 2 2012	BATCH 3 2015	BATCH 4 2016	BATCH 5 2017	BATCH 6 2019	BATCH 7 2020	BATCH 8 2022
UMPEDAC, UM Renewable Energy **UMBI, UKM** Cancer Biomarkers **IBS, UPM** Animal Vaccines and Therapeutic **INFORMM, USM** Diagnostics Platform **CDR, USM** Behavioral Research in Addiction **ARI, UiTM** Islamic Financial Criminology	**INOS, UMT** Sustain-ability of Marine Ecology	**PRC, UM** Optical Devices for Communication **IOES, UM** Interaction of Air-Ocean-Land **REDAC, USM** Sustainable Urban Stormwater Management **IMEN, UKM** MEM's for Biomedical - Focus Study : Artificial Kidney **WCC, UTM** Antenna and Propaga-tion for 5G Wireless Communications **CISIR, UTP** Neuro Chemical Imag-ing Under Biomedical Image Analysis	**AMTEC, UTM** Water Reclamation **IKG, UTM** Vibration Engineering and Integrity Assessment	**INTROP, UPM** Tropical Wood and Fibre **ITAFoS, UPM** Tropical Agrifood	**TIDREC, UM** Vector & Vector-borne Infectious Disease **CBBR, UTP** Biomass Thermo-chemical Conversion Technolo-gies	**AKUATROP, UMT** (Future Food: Sustainable Shellfish Aquacul-ture)	**ISE, UNITEN** (Advanced Energy Harvest-ing Tech-nologies – Rapid Decarboni-sation)

C. The Roles and Responsibilities of Penang STEM Centres

1. Penang STEM: A Catalyst for a Thriving STEM Ecosystem

Penang STEM serves as the unifying platform coordinating various independent STEM learning centres across Penang. This collaborative approach fosters a synergistic ecosystem, leveraging the strengths of each centre to spark student interest in STEM and ensure that the state's STEM programmes embed real-world technology learning in schools. The vision is to propel Penang to the forefront as a regionally recognised Centre of Excellence in STEM education.

Penang STEM's mission transcends mere coordination. It is dedicated to nurturing the talent needed to propel Penang's technological-driven economy and ensures its success in the transformative era of the Fourth Industrial Revolution.

Facilitating collaboration and resource allocation

Beyond its unifying role, Penang STEM is a strategic body that monitors resource needs. This ensures that STEM centres have the necessary support to incubate innovative programmes effectively. Additionally, Penang STEM facilitates tripartite engagement by fostering strong partnerships between the government, industry leaders, and schools. This collaborative approach assures a comprehensive and future-oriented approach to STEM education.

Large-scale impact: Programmes tailored for diverse needs

Penang STEM has initiated large-scale STEM pipeline development programmes in schools in partnership with IHLs and technical training institutes. Initiatives like Technical Skill Learning (TSL), STEM Future-Proofing (SFP), and the StepUP initiative cater to a broad spectrum of students. Working hand-in-hand with the Penang State Education Department, the Ministry of Education, the Ministry of Science, Technology and Innovation, universities, colleges, technical training institutions

and industry partners, these programmes are designed to ignite the passion for STEM in both academically inclined students and those with a more practical focus. Delivery of these programmes is entrusted to the three esteemed STEM centres: TDP, PSC and PMP in partnership with universities, colleges and technical training institutions. Each centre brings its unique expertise, ensuring a well-rounded learning experience.

2. Tech Dome Penang: Igniting a Passion for Science and Technology

Tech Dome Penang (TDP) is a non-profit science discovery centre that opened in July 2016 through a collaborative initiative between the Penang State Government and public-private partnerships. Managed by the Penang Tech Centre, TDP is a leading resource for fostering scientific curiosity and exploration in the region.

Spanning a spacious 45,000 square feet, TDP boasts an impressive collection of over 120 interactive exhibits. These engaging displays offer a dynamic learning environment, igniting a passion for science and technology in visitors of all ages. TDP is also part of the key players for the federal government initiative under MOSTI in Rangkaian Kolabotif Pusat Sains Malaysia (MySains) and Jawatankuasa Angkasa Kebangsaan (JANGKA).

Inspiring future generations

TDP's mission extends beyond edutainment. It aspires to be a central source of inspiration, where science, technology, industry, and the community converge. Through its programmes and exhibits, TDP fosters scientific learning, nurturing a deep understanding of scientific principles. It encourages creativity and problem-solving skills to develop new technologies. It also exposes future generations with the skills and vision to transform ideas into reality.

Vision for a brighter tomorrow

TDP envisions a future where children are empowered to become the next generation of technologists. By cultivating a spirit of inquiry and a fascination with science, engineering, and technology, TDP plays a vital role in shaping a brighter tomorrow. It aspires to be a central hub where science, technology, industry and the community converge.

3. Penang Science Cluster: Embedding Innovation in Young Minds

The Penang Science Cluster (PSC) is a non-profit organisation initiated in 2009 and incorporated in 2012 through a collaborative effort between the Penang State Government and industry leaders. Guided by a board of directors from Penang's renowned multinational and leading local companies, PSC operates as a tax-exempt organisation. Its mission is to cultivate a robust talent pipeline in Penang and Malaysia. PSC achieves this by:

- Sparking curiosity among young children by embedding real-world science and technology applications through engaging, hands-on and inquiry-based programmes beyond the classroom; and
- Cultivating a culture of innovation and entrepreneurial spirit among Penang's youth.

Building a strong foundation for the future

PSC's commitment to science education translates into real-world impacts. The organisation supports over 200 schools with its TechMentor Lego Robotics, Embedded Systems, Coding, and Radio Astronomy programs. These programmes are delivered by a dedicated team of over 150 volunteer mentors from the industry, further enriching the learning experience. Additionally, PSC provides loaner hardware and software to participating schools, all at no cost.

The centre actively encourages the establishment of science cafes in population centres and MakerLabs in schools throughout Penang. This hands-on learning and the maker movement empower students to explore STEM subjects in a fun and engaging way.

PSC's reach extends beyond schools. The organisation spearheads the prestigious Penang International Science Fair (PISF), an annual event that showcases cutting-edge technologies from industry leaders. This event attracts around 60,000 attendees every year, serving as a platform to educate and inspire students.

4. Penang Math Platform: Unleashing Mathematical Potential

As part of the Penang STEM learning initiative, the Penang Math Platform (PMP) is a mathematics learning centre set up in 2017. While other STEM centres focus on science, technology and engineering, PMP fills the crucial role of nurturing a strong foundation in mathematics.

PMP's programmes aim to boost children's confidence and competence in math through guided learning and engaging activities. Students explore the world of math puzzles and cubes, igniting their logical and critical thinking skills while solving problems. Interactive workshops keep students motivated to stimulate mathematical skills through a journey of intellectual discovery.

Diverse learning opportunities

PMP offers a comprehensive range of math programmes, from basic to advanced levels. Students can choose math tutorials from the national syllabus, Singapore Math and Mental Arithmetic. Flagship Japanese Math class for pre-schoolers is organised to build an entry-level foundation for math appreciation and interpersonal communication. Children will acquire fundamental knowledge and skills in numbers, quantities and geometry besides fostering the ability to think, make decisions and express themselves. Meanwhile, the Seriously Addictive Mathematics (S.A.M) class is modelled

after the Singapore Primary and Lower Secondary Mathematics curriculum framework, rated as one of the most recognised and successful mathematics programmes in the world, according to the Trends in International Mathematics and Science Study (TIMSS) and Programme for International Student Assessment (PISA) surveys.

Structured learning and beyond

The classes have a clear and structured curriculum aligned with national standards that ensures students' steady progress and mastery of key concepts. They will learn how to code and solve problem techniques throughout the course. They do not only focus on teaching them tech skills but also focus on how to train students on their problem-solving skills and how to deliver their ideas.

By incorporating elements of world-renowned programmes like Singapore Math, PMP prepares students for success in their academic journeys and beyond.

Glossary of Terms

AI	Artificial Intelligence
AKUATROP	Institute of Tropical Aquaculture and Fisheries
AMTEC	Advanced Membrane Technology Research Centre
APAC	Asia Pacific
AR	Augmented Reality
ARI	Accounting Research Institute
BNM	Bank Negara Malaysia
CAD	Computer-aided Design
CAGR	Compounded Annual Growth Rate
CAM	Computer-aided manufacturing
CAPEX	Capital Expenditures
CBBR	Centre for Biofuel and Biochemical Research
CDR	Center for Drug Research
CEDEC	Collaborative Microelectronics Design Excellence Centre
CEO	Chief Executive Officer
CISIR	Center for Intelligent Signal and Imaging Research
CNC	Computer Numerical Control
CS	Computer Science
DGBS	Digital Global Business Services
DOSM	Department of Statistics Malaysia
E&E	Electrical and Electronics
EDA	Electronic Design Automation
EMS	Emergency Medical Services
EV	Electric Vehicle
FDI	Foreign Direct Investments

FPT	Financing and Promoting Technology
GDP	Gross Domestic Products
GE	Graduate Employability
HICoE	Higher Institution Centres of Excellence
HOTS	Higher Order Thinking Skills
HRD	Human Resources Director
HRDC	Human Resource Development Council
IAT	Industrial Automation Technology
IBS	Institute of Bioscience
IC	Integrated Circuit
ICT	Information and Communication Technology
IHL	Institution of Higher Learning
IKG	Institute of Noise and Vibration
IMEN	Institute of Microengineering and Nanoelectronics
INFORMM	Institute for Research in Molecular Medicine
INOS	Institut Oseanografi dan Sekitaran
INTROP	Institut Perhutanan Tropika dan Produk
IOES	Institute of Ocean and Earth Sciences
IP	Intellectual Property
ISE	Institute of Sustainable Energy
ITAFoS	Institute of Tropical Agriculture and Food Security
JANGKA	Jawatankuasa Angkasa Kebangsaan
KAIST	Korea Advanced Institute of Science and Technology
KPI	Key Performance Indicator
LLM	Large Language Models
M&E	Mechanical and Electrical
MATRADE	Malaysia External Trade Development Corporation
MD	Malaysia Digital
MIDA	Malaysian Investment Development Authority

MITI	Ministry of International Trade and Investment
MNC	Multinational Corporation
MoD	Ministry of Digital
MoE	Ministry of Education
MoF	Ministry of Finance
MoHA	Ministry of Home Affairs
MoHE	Ministry of Higher Education
MoHR	Ministry of Human Resources
MOSTI	Ministry of Science, Technology and Innovation
MSIA	Malaysia Semiconductor Industry Association
MySains	Rangkaian Kolaboratif Pusat Sains Malaysia
NIMP	New Industrial Master Plan
NOSS	National Occupational Skills Standards
NPI	New Product Introduction
NRECC	Natural Resources, Environment and Climate Change
NSS	National Semiconductor Strategy
NTHU	National Tsing Hua University
NTU	National Taiwan University
ONE	Overseas Network Expertise
OPEX	Operating Expenses
OSAT	Outsourced Semiconductor Assembly and Test
PCDA	Penang Chip Design academy
PFF	Penang Future Foundation
PISA	Programme for International Student Assessment
PISF	Penang International Science Fair
PLC	Programmable Logic Controllers
PMP	Penang Math Platform
PMT	Precision Machining Technology
PSC	Penang Science Cluster

PSDC	Penang Skills Development Centre
PVP	Professional Visit Pass
QAT	Quality Assurance Technology
R&D	Research and Development
RDCI	Research, Development, Commercialisation and Innovation
RE	Renewable Energy
REDAC	River Engineering & Urban Drainage Research Center
RM	Ringgit Malaysia
RMK	Rancangan Malaysia Ke
SAM	Seriously Addictive Mathematics
SEED	Strategy Economic Ecosystem Development
SFP	STEM Future-Proofing
SG	Singapore
SK	South Korea
SLDN	Sistem Latihan Dual Nasional
SME	Small and Medium-sized Enterprises
STEM	Science, Technology, Engineering, and Mathematics
TDP	Tech Dome Penang
THRIVE	Transform, Hire, Retain, Invest, Value and Enable
TIDREC	Tropical Infectious Diseases Research & Education Centre
TIMSS	Trends in International Mathematics and Science Study
TSL	Technical Skill Learning
TVET	Technical and Vocational Education and Training
UiTM	Universiti Teknologi MARA
UKM	Universiti Kebangsaan Malaysia
UM	Universiti Malaya
UMBI	UKM Medical Molecular Biology Institute
UMPEDAC	UM Power Energy Dedicated Advanced Centre
UMPSA	Universiti Malaysia Pahang Al-Sultan Abdullah

UMT	Universiti Malaysia Terengganu
UNIMAP	Universiti Malaysia Perlis
UNITEN	Universiti Tenaga Nasional
UPM	Universiti Putra Malaysia
USA	United States of America
USM	Universiti Sains Malaysia
UTeM	Universiti Teknikal Malaysia Melaka
UTM	Universiti Teknologi Malaysia
UTP	Universiti Teknologi PETRONAS
VR	Virtual Reality
WCC	Wireless Communication Centre

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