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Electronic Industry Ecosystem in Malaysia: Challenges and Opportunities in Innovation, Talent, and Regulation

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1. Executive Summary

1.1 Introduction

Malaysia stands at a pivotal moment in its journey to solidify its position as a global leader in the electronics industry. The sector, a cornerstone of the nation's economy, faces mounting challenges in innovation, talent management, and regulatory adaptation. Amid these obstacles lies an unprecedented opportunity to transform Malaysia into a premier hub for advanced electronics, leveraging its strategic location, skilled workforce, and growing technological ecosystem. The Malaysian electronics industry spans multiple sub-sectors (electronic components, consumer electronics, industrial electronics, electrical products), each with diverse products and activities (Table 1.1), reflecting the broad scope of the ecosystem under the national industrial plan.

Table 1.1: New Industrial Master Plan 2030 by MITI (National Industrial Master Plan (NIMP), 2023)

Sub-sectors	Products/Activities	
Electronic components	• Integrated circuit (IC) design • Wafer fabrication • Light Emitting Diode substrate	• Epitaxy manufacturing • Printed circuit board (PCB) • Precision plastic parts
Consumer electron	• TV/ Radio receivers • Media players • Speakers	• Electronic games • Embedded systems
Industrial electronics	• Computer and peripherals • Data storage • Office equipment	• Telecommunication devices • Transmitters and routers
Electrical products	• Electric motors, generators & transformers • Solar cells, modules & Balance of Systems (BoS)	• Wire, cables and batteries • Lighting equipment & luminaires • Domestic appliances

This position paper identifies critical challenges facing Malaysia's electronics industry ecosystem and proposes targeted opportunities to address them. In particular, it examines three key dimensions that influence firm performance: Innovative Performance (IP), Talent Management (TM), and the Regulatory Environment (RE). Drawing inspiration from successful models across Asia (such as Singapore's A*STAR research agency and South Korea's Daedeok Innopolis), the paper integrates qualitative insights and quantitative evidence to recommend strategic government interventions. These interventions are designed to align with global standards and future industry needs, positioning Malaysia's electronics sector for sustainable growth.

Below is a summary of actions for the 3 key focus areas and our recommendations.

Table 1.2: Summary of Focus Area and Recommendation

Challenge Area	**Key Recommendation**	**Agency Addressed to**	**Time Duration**	**Consequence if not carried out**
Innovative Performance (Section 3.1.1)	Centralized R&D Hub: Create a national innovation center to strengthen industry–academia collaboration and accelerate commercialization of research. (Modelled after A* STAR). Public–Private Partnerships: Promote co-funded R&D between MNCs, SMEs, and universities to share risk, expertise, and drive impactful innovation. Global Technology Integration: Form strategic alliances with international tech leaders and join global research consortia to access advanced knowledge and stay aligned with global trends.	MOSTI MIDA MITI	Short-term (1–2 years)	Lack of a Centralized R&D Hub: Fragmented research efforts, weak industry–academia collaboration, low commercialization rates, and continued dependence on imported technologies. Absence of Public–Private Partnerships: Limited technology transfer, underfunded R&D, slow SME growth, higher innovation risk borne by single entities, and reduced global competitiveness. No Access to Global Technology Networks: Technological isolation, slow adoption of advanced technologies, skills mismatch, declining innovation capacity, and loss of relevance in global value chains.
Talent Management (Section 3.1.2)	**Brain Drain of High-Skilled Engineers** Strengthen and expand the Returning Expert Programme (REP) by offering competitive tax incentives, fast-track residency, research grants, and leadership roles in strategic E&E projects. **Underutilization of Women and Mid-Career Talent** Implement inclusive talent policies such as flexible work		Short- to Medium-term (2–4 years)	Ongoing loss of senior engineers and technical leaders, weak mentorship pipelines, reduced innovation capacity, and slower movement into high-value R&D activities.

	arrangements, return-to-work programmes for women engineers, and mid-career reskilling grants to expand the effective talent pool. **Engineering Talent Shortage** Launch a National "SkillsMalaysia" Programme focused on semiconductor engineering, AI, embedded systems, and Industry 4.0 skills, combining reskilling, micro-credentials, and industry-certified training. **Graduate Skills Mismatch & Low Job Readiness** Revamp engineering curricula through mandatory industry co-designed modules, extended internships (6–12 months), and dual-training models aligned with E&E sector needs. **Weak Talent Retention & Career Progression** Introduce structured national engineering career pathways (technical specialist vs managerial tracks), supported by continuous upskilling subsidies and productivity-linked wage progression. **Declining STEM Participation and Interest** Implement a National STEM Promotion Strategy by introducing early STEM exposure (primary and secondary levels), hands-on project-based learning, industry-led mentorship, national STEM competitions, and sustained media campaigns to			

	reposition engineering as an attractive, future-ready career.			
Regulatory Environment (Section 3.1.3)	Implement a One-Stop Digital Portal for licenses and adopt "Regulatory Sandboxes" to allow pilot testing of new technologies under relaxed rules.	MIDA MPC Customs SIRIM	Short-term (1–2 years)	High operational costs due to bureaucratic delays, supply chain disruptions, and reduced attractiveness for foreign investment.

This study contributes a validated RBV-anchored framework that jointly models innovation capacity, talent, and regulation for firm performance in Malaysia's E&E sector. Using mixed methods (11 cases + PLS-SEM survey, N=71), we show innovation has the strongest association with performance and convert findings into a phased, implementable policy roadmap.

1.2 Background and Context

The global electronics industry is undergoing rapid evolution, driven by technological advancements such as artificial intelligence (AI), quantum computing (QC), and green technologies. Malaysia's electronics sector contributes significantly to national Gross Domestic Product (GDP) and exports. However, its competitiveness is constrained by persistent underinvestment in research and development (R&D), a widening talent gap, and regulatory inefficiencies. Lessons from regional leaders underscore the pivotal role of government initiatives in overcoming these constraints. For example, Singapore's A*STAR model illustrates how public R&D hubs can foster innovation, while South Korea's Daedeok Innopolis demonstrates the impact of sustained government support in creating vibrant innovation clusters. These examples highlight that strategic government intervention can bridge talent gaps and streamline regulations, thereby strengthening the innovation ecosystem. Building on such frameworks while addressing Malaysia's unique context, this paper situates its analysis in both local and global contexts to ensure relevance to international readers and policymakers.

1.3 Objectives

The objectives of this paper are threefold:

- **Identify Key Barriers:** Pinpoint and analyze the critical barriers in innovation performance (IP), talent management (TM), and the regulatory environment (RE) that are limiting the performance of firms in Malaysia's electronics industry.
- **Validate Determinants of Performance:** Using a robust theoretical lens (the Resource-Based View, RBV), empirically confirm how these factors (IP, TM, RE) influence firm performance. This involves qualitative case studies and a quantitative survey to test specific hypotheses on the impact of innovation, talent, and regulation on firm outcomes.
- **Recommend Strategic Interventions:** Provide actionable, evidence-based recommendations for government and industry stakeholders to address these barriers. The ultimate aim is to position Malaysia as a leader in the global electronics value chain by fostering innovation capacity, developing a sustainable talent pipeline, and aligning the regulatory framework with international best practices.

1.4 Key Recommendations

This paper advocates a holistic approach to enhancing Malaysia's electronics sector. The key policy recommendations are summarized below, each aligned with one of the three focus areas (IP, TM, RE) and drawing on international best practices and empirical findings:

1.4.1 Enhancing Innovative Performance (IP)

- **Centralized R&D Ecosystem**: Establish a national innovation hub modeled after Singapore's A*STAR and South Korea's Daedeok Innopolis to drive industry-academia collaboration and commercialization of R&D.
- **Public-Private Partnerships (PPPs)**: Incentivize technology transfer and co-funded innovation projects between multinational corporations (MNCs), local small and medium enterprises (SMEs), and universities. These PPPs would share risks and pool expertise for high-impact R&D.
- **Access to Global Technology Networks**: Build strategic alliances with global technology leaders to facilitate knowledge exchange and the localization of advanced

technologies. For instance, participate in international semiconductor consortia and AI research networks to keep local innovation abreast of global trends.

1.4.2 Improving Talent Management (TM)

- **National Upskilling Initiatives**: Launch a "SkillsMalaysia" program (inspired by Singapore's SkillsFuture initiative) to upskill the workforce in semiconductor engineering, AI, robotics, and other critical areas. This would involve government-subsidized training and certification programs to address current skill gaps.
- **Science, technology, engineering and mathematics (STEM) Education Reforms**: Revamp STEM curricula in partnership with industry. Introducing industry-relevant content in universities and technical institutes, perhaps through guest lecturers from tech firms and updated lab facilities, will better prepare graduates for electronics industry careers.
- **Talent Retention**: Develop incentives to retain skilled professionals and attract Malaysian talent abroad to return (reverse brain drain). Policies could include tax breaks for returning experts, competitive research grants for young scientists, and clear career advancement pathways in domestic firms.

1.4.3 Refining the Regulatory Environment (RE)

- **Streamlining Approvals and Digitalization**: Digitize and integrate regulatory processes (drawing on models like Indonesia's Online Single Submission OSS system) to reduce bureaucratic red tape for businesses. A one-stop online portal for permits and licenses in the electronics sector would greatly improve the ease of doing business.
- **Promoting ESG Compliance**: Introduce clear guidelines, incentives, and timelines for firms to adopt Environmental, Social, and Governance (ESG) best practices. For example, Thailand's Securities and Exchange Commission (SEC) requires listed companies to undergo ESG training and compliance; Malaysia could implement similar mandates and offer tax incentives or recognition for early adopters of ESG standards.
- **Adaptive Regulations**: Establish regulatory **sandboxes** that allow pilot testing of innovations (e.g., in fintech, green tech, advanced manufacturing) under relaxed regulations. This encourages experimentation while the government updates laws to accommodate new technologies. Periodically review and update industry regulations (on safety, standards, etc.) to ensure they keep pace with technological advancements.

1.5 Structure of the Position Paper

This position paper is organized into seven chapters (plus supporting sections) to guide readers through the current state of Malaysia's electronics industry, the issues it faces, and the practical steps needed to address them. The structure is designed to be clear and useful for government stakeholders, policymakers, industry professionals, and even interested members of the public. Each chapter has a specific focus and purpose, contributing to a cohesive argument that Malaysia must improve innovation, develop talent, and refine regulations in its electronics sector to achieve sustainable growth. Below is a breakdown of each chapter, explaining what it covers and how it supports the paper's overall recommendations.

1.5.1 Chapter 1 Executive Summary

The paper opens with an Executive Summary that provides a concise overview of the entire document. This section highlights the key points and recommendations upfront. It briefly introduces the challenges in innovation, talent, and regulation facing Malaysia's electronics industry and outlines the major recommendations to tackle these issues. The Executive

Summary distills the essence of the position paper that including the context, objectives, and suggested actions, so that busy decision-makers can quickly grasp the main messages.

By presenting the core findings and proposed solutions in summary form, this chapter sets the stage for the rest of the paper. It ensures all readers start with a clear understanding of the issues at hand and the strategic direction of the recommendations. In practical terms, the Executive Summary acts as a roadmap of the paper's argument, emphasizing why strengthening innovation (IP), nurturing talent (TM), and improving the regulatory environment (RE) are critical. This motivates stakeholders to delve into the detailed chapters that follow or, at the very least, walks away with the paper's primary call to action.

1.5.2 Chapter 2 Introduction

The Introduction chapter provides the background and context for the position paper. It describes the current state of Malaysia's electronics sector, explaining its economic significance, key players, and recent trends. This chapter issues the questions like: *Why is the electronics industry important to Malaysia?* and *What recent developments or challenges make this study timely?* It also clearly states the objectives and scope of the paper that what the paper intends to achieve and the aspects of the electronics ecosystem it will cover. Essentially, the Introduction gives readers a baseline understanding of the industry's landscape and the rationale behind focusing on innovation, talent, and regulation.

By setting the stage, the Introduction ensures that readers appreciate why the topic matters. It frames the electronics industry as a cornerstone of Malaysia's economy that is at a pivotal point, facing pressures but also opportunities. This context justifies the need for a focused analysis on innovation capacity, talent development, and regulatory frameworks. In a practical sense, this chapter engages policymakers and industry leaders by underlining the significance of addressing these areas, thereby preparing the audience for the detailed problem analysis and solutions in later chapters.

1.5.3 Chapter 3 Problem Statement

The Problem Statement chapter clearly identifies and articulates the major challenges confronting Malaysia's electronics industry. It breaks down the problems into three key categories, Innovative Performance (IP), Talent Management (TM), and the Regulatory Environment (RE), which are recurring themes throughout the paper. In this chapter, each category of challenge is explained in turn, to show exactly what issues are hindering the industry's growth:

- *Innovation (IP):* Barriers to innovation are discussed, such as limited research and development funding, difficulty in accessing advanced technologies, and weak collaboration between industry and research institutions. These issues impede local firms from moving up the value chain or developing new products.
- *Talent (TM):* Challenges in talent development are highlighted, including a shortage of skilled engineers and technical professionals, a declining interest among Malaysian youth in STEM (science, technology, engineering, and mathematics) careers, and the "brain drain" effect of skilled workers moving abroad. These talent gaps threaten the industry's ability to innovate and expand.
- *Regulation (RE):* Regulatory hurdles are examined, for instance bureaucratic inefficiencies and delays in getting approvals, complex or outdated regulations that can slow down business, and the pressure of meeting new international standards (such as

stringent supply-chain or sustainability requirements). Such regulatory issues can discourage investment and innovation in the electronics sector.

Beyond listing the problems, this chapter also emphasizes why government intervention is crucial in each of these areas. It explains that without strategic action (like policy changes, incentives, or programs), these challenges will continue to hold back the industry's performance.

The Problem Statement serves as the foundation for the entire paper. By pinpointing the specific obstacles in innovation, talent, and regulation, it creates a sense of urgency and direction for the rest of the document. This clarity ensures that subsequent chapters remain focused on solving the real, identified problems. For the audience, this chapter makes it easy to see *what* issues need addressing and *why* they matter. In doing so, it directly leads into the next chapters: after understanding the problems, the reader is primed to explore deeper evidence of these challenges and then consider possible solutions. Essentially, Chapter 3 defines the targets that the position paper's recommendations will hit.

1.5.4 Chapter 4 Challenges and Opportunities in Malaysia's Electronics Industry

Chapter 4 provides an in-depth exploration of the challenges outlined in the previous chapter, and importantly, it also identifies opportunities or silver linings in addressing those challenges. This is the core analytical chapter of the paper, where each problem area (IP, TM, RE) is examined through detailed examples, case studies, and qualitative insights. Rather than discussing issues in abstract, the paper uses real-world case studies from Malaysia's electronics sector to illustrate the impact of these challenges and the potential benefits of overcoming them. For example, the chapter includes cases such as:

- *Technology Adoption (Innovation):* A case study on **Gallium Nitride (GaN) technology adoption** shows how Malaysian firms are trying to embrace cutting-edge semiconductor technology. It highlights the innovation challenges (like needing R&D support and tech transfer) but also the opportunity, if successful, Malaysia could become a leader in a high-value niche. Other cases, like advancements in **AI and quantum computing**, demonstrate the opportunities in emerging technologies if the innovation ecosystem is strengthened.
- *Workforce and Skills (Talent):* Several case studies address talent issues, for instance, one examines the **limited supply of Electronics & Electrical engineering graduates**, and another looks at the **declining interest in engineering among youth**. There's also a case on the **impact of brain drain**. These stories shed light on how the talent gap is affecting companies and what could be gained if Malaysia produces and retains more skilled workers.
- *Regulatory Impact (Regulation):* The chapter also covers instances of regulatory hurdles, such as a case study of a company facing **regulatory delays that disrupted its supply chain**, and another involving **compliance with international responsible business standards** in electronics manufacturing. These illustrate how red tape or slow adaptation to global standards can hurt industry growth, but conversely, they show that streamlining regulations could remove significant roadblocks.

Alongside these case studies, the chapter likely includes a **qualitative analysis** summarizing common factors across the cases. It "connects the dots" from the individual examples to identify broader trends, for instance, how innovation, talent, and regulatory factors interact to influence a firm's performance. By the end of the chapter, the paper synthesizes these insights, essentially extracting the key variables or ingredients (innovative capacity, skilled human

capital, supportive regulations) that are needed for companies to thrive. This forms a bridge to the more quantitative analysis later.

Chapter 4 strengthens the paper's argument by providing evidence and depth. For policymakers and industry leaders, these concrete examples make the challenges tangible and relatable. Instead of just saying "we have an innovation problem," the paper shows what that looks like on the ground and what opportunities are being missed as a result. This evidentiary approach builds credibility. It demonstrates that the recommendations to come are grounded in reality. Moreover, by highlighting opportunities amidst the challenges, the chapter maintains a solutions-oriented tone: it's not just diagnosing issues, but also hinting at how improvements (if achieved) can lead to positive outcomes like technological leadership, a stronger workforce, or smoother business operations. All this analysis directly informs the recommendations in the next chapter. In short, Chapter 4 provides the detailed justification for *why* the specific actions later proposed are necessary and how they can make a difference. It ensures that when the paper moves on to solutions, the reader understands the context and the stakes involved.

1.5.5 Chapter 5 Actionable Recommendations

Having established the problems and evidence, Chapter 5 lays out practical, actionable steps for the government (and by extension other stakeholders) to implement in order to strengthen the electronics industry ecosystem. This is essentially the "solution" chapter, organized around the same three key areas: innovation, talent, and regulation, to directly address the challenges identified earlier. The recommendations are presented in clear, policy-oriented terms, making it easy for decision-makers to understand what needs to be done. The chapter is typically structured into subsections for each focus area:

- **Enhancing Innovative Performance (IP):** Strategies here focus on spurring innovation. For example, the paper might recommend increasing access to R&D funding and tax incentives for electronics companies that invest in new technologies. It likely suggests promoting stronger industry-academia collaboration (such as partnerships between universities and electronics firms to work on research projects or technology commercialization), and cultivating an innovation culture within the industry (encouraging risk-taking, supporting startups, and creating innovation hubs or clusters). The goal of these steps is to create an environment where Malaysian electronics companies can continuously develop new products, processes, and technologies to stay competitive globally.
- **Improving Talent Management (TM):** These recommendations target the development and retention of skilled human capital. They might include education and training reforms, for instance, updating engineering curricula, investing in STEM education at schools, or expanding vocational training programs specialized in electronics manufacturing. Another set of actions could involve ensuring a sustainable pipeline of talent, such as scholarships or incentives to increase the number of graduates in electrical and electronic engineering, and programs to inspire the next generation (campaigns or initiatives to spark youth interest in engineering and tech careers). Importantly, this section also addresses retaining talent in-country: measures to curb the brain drain could be suggested, like creating attractive career opportunities and improving working conditions so Malaysian engineers and scientists are less inclined to seek jobs abroad. Enhanced industry–academia partnerships (internships, apprenticeships, mentorship programs) could also be featured to ensure graduates are industry-ready.

- **Refining the Regulatory Environment (RE):** Recommendations in this area aim to make it easier to do business in the electronics sector by improving government processes and rules. This could involve simplifying regulatory procedures (cutting unnecessary red tape, speeding up permit and license approvals), and enhancing transparency and consistency in how regulations are applied (so companies know what to expect and can plan accordingly). The paper may advise introducing more regulatory flexibility and adaptability, meaning regulators should be quick to update rules in line with technological changes and industry needs (for example, adjusting standards as new tech like autonomous systems or advanced materials emerge). Strengthening public–private dialogue is likely another recommendation to create platforms for industry to regularly consult with regulators, ensuring policies are formulated with industry input. Additionally, the chapter might propose the digitalization of regulatory processes (using online systems for filings, approvals, and compliance reporting to reduce hassle and errors) and providing incentives or support for firms to comply with international standards (for instance, helping local manufacturers meet global sustainability or safety standards). Overall, these steps are about making the regulatory climate a competitive advantage rather than a bottleneck, fostering a business-friendly environment that still upholds quality and safety.

Furthermore, Chapter 5 doesn't just list these recommendations in isolation. It often draws on successful examples from other countries to reinforce them. In this paper, there is a dedicated section that looks at sustainable growth strategies adapted from proven models in other Asian economies. For instance, it might highlight how countries like Singapore, South Korea, or Vietnam improved their electronics industries by implementing similar innovation funds, talent programs, or regulatory reforms. By referencing these international best practices, the paper provides Malaysia with real-world proof that these recommendations can work, and it offers a template or inspiration for local policy adaptation. This comparative insight adds a practical dimension: it shows policymakers that Malaysia can learn from and avoid repeating the mistakes of others, accelerating improvement by adopting strategies that have been effective elsewhere.

This chapter is the heart of the position paper's policy impact, converting analysis into action. Each set of recommendations directly tackles the problems laid out earlier, which shows a logical flow: *we identified what's wrong, now here is how to fix it*. For the overall argument, Chapter 5 is crucial because it provides the **solutions and the "how-to"** that answer the paper's central question of how Malaysia can enhance innovation, talent, and regulation in electronics. It contributes practicality and implementability to the document – without this section, the paper would be all diagnosis and no cure. By being explicit and structured (IP, TM, RE), the recommendations also make it easy for various stakeholders to find their part in the solution (for example, education ministries can focus on the talent subsection, investment agencies on innovation, etc.). This clarity and action-oriented tone ensure that the paper is not just informative but also a useful guide for decision-making and policy formulation. In summary, Chapter 5 links the earlier chapters' findings to concrete steps, thereby forming the bridge from understanding the issues to taking action, which is the ultimate goal of the position paper.

1.5.6 Chapter 6 Quantitative Analysis of Government Interventions and Firm Performance

Chapter 6 adds a data-driven analysis to the paper, examining how the interventions and factors discussed (innovation, talent, regulatory environment) statistically relate to the performance of

firms in Malaysia's electronics industry. In essence, this chapter answers the question: *Do improvements in IP, TM, and RE actually make a measurable difference in company success?* To answer this, the chapter outlines the research methodology used by the authors and then presents the findings of the quantitative study. The methodology likely combines insights from the earlier qualitative case studies with a formal analytical framework (the paper mentions using a Resource-Based View (RBV) approach, which in simple terms is a management theory used to assess how a firm's internal resources and capabilities contribute to performance). Key elements of this chapter include: how data was collected (for example, through surveys or industry data), what hypotheses were tested, and which statistical techniques were applied to evaluate the impact of innovation capacity, talent development, and regulatory factors on outcomes like firm productivity, profitability, or growth. After explaining the approach, the chapter presents the results, for instance, it may show that companies which invest more in R&D (innovation) or have access to skilled workers (talent) tend to perform better, or that certain regulatory improvements correlate with higher efficiency in firms. Any significant correlations or trends are highlighted to validate the importance of IP, TM, and RE. The chapter may also identify if one factor has more impact than others, or if there are threshold effects (e.g., a certain level of talent is required before innovation investment pays off, etc.). All of this is typically backed by statistics (charts, tables, or metrics like correlation coefficients, p-values, etc., though in a position paper the presentation would be kept policy-friendly).

The inclusion of a quantitative analysis ensures that the paper's recommendations are grounded in evidence and facts, not just theory or anecdote. For the overall argument, this chapter provides a proof point: it demonstrates empirically that focusing on innovation, talent, and regulatory improvements is not only theoretically good, but actually linked to better performance in the real world. This is very persuasive for policymakers and industry stakeholders who want to see justification for why certain actions are worth investing in. It turns the argument from "we believe these changes will help" into "data shows these changes will help." By validating the positive impact of the recommended interventions, Chapter 6 increases the credibility of the entire position paper. It also helps prioritize efforts – for example, if the data reveals that talent management has the strongest effect on firm success, the government might choose to allocate more resources to that area. Conversely, if one of the factors shows a weaker-than-expected impact, the recommendations related to it can be fine-tuned. In summary, this chapter underpins the recommended policy actions with quantitative evidence, reinforcing the message that improving IP, TM, and RE will lead to tangible economic benefits. This evidence-based approach appeals to the analytical side of public policy decision-making and provides a solid foundation for the strategic roadmap presented in the conclusion.

1.5.7 Chapter 7 Conclusion and Strategic Roadmap

The final chapter concludes the position paper by summarizing the key insights and charting a path forward. It typically starts with a summary of the key points that reiterating the major challenges identified (in innovation, talent, and regulation) and the corresponding high-level solutions proposed. This recap helps remind readers of the journey through the paper and the logic of the argument. The conclusion then moves on to convey final thoughts on the importance of strategic interventions by the government and stakeholders. Here, the tone is often motivational and forward-looking: it underscores that by taking the recommended actions, Malaysia can achieve its vision of a thriving, innovative electronics industry.

Importantly, this chapter also provides a Strategic Roadmap for implementation, essentially a high-level guide or set of recommendations on how to execute the changes proposed. Rather than introducing new recommendations, this roadmap gives a practical structure to the existing ones. For example, it might outline immediate steps versus long-term steps, assign broad responsibilities (which ministries or agencies should lead certain initiatives), or suggest a timeline/prioritization (what should be tackled first). It may also highlight the need for continuous collaboration between government, industry, and educational institutions to ensure these strategies succeed. In this way, the conclusion doesn't just stop at saying "here are the solutions" – it goes further to discuss **"how do we start moving on these solutions?"** and **"what is the end goal we're collectively working towards?"**. The chapter often ends on an optimistic **vision for the future** of Malaysia's electronics sector, painting a picture of what success looks like (for instance, Malaysia becoming a regional leader in high-tech manufacturing, having a robust pipeline of tech talent, and a regulatory system that attracts investment and innovation). This vision is tied back to the interventions discussed, reinforcing that achieving it will require commitment to the recommended course of action.

The Conclusion brings the entire argument full circle and is crucial for ensuring the paper has a lasting impact. By summarizing the findings and recommendations one more time, it reinforces the message in the reader's mind – this repetition of the core argument (challenges → actions → expected outcomes) helps solidify understanding. The strategic roadmap portion is particularly valuable for government stakeholders and industry leaders as it translates the ideas into an **implementation strategy**, which is what many policy-oriented readers are looking for. It answers the "what now?" question. This ensures the paper is not just a theoretical exercise but a **practical guide moving forward**. In doing so, the conclusion elevates the discussion from analysis to action: it is a call-to-action that encourages stakeholders to take the insights of the paper and apply them. It also aligns everyone on a common goal or vision, which is important for coordinated efforts. Overall, Chapter 7 ties all the threads together. It reminds us why addressing innovation, talent, and regulation in unison is vital for Malaysia's future, and it leaves the audience with a clear understanding of the next steps and an inspirational outlook. This final reinforcement of the paper's policy-oriented argument makes the case that, with the right moves made now, Malaysia's electronics industry can overcome its challenges and seize the opportunities in the years ahead.

1.6 Major Contribution of the Position Paper

This position paper makes a strategic and timely contribution to Malaysia's national dialogue on industrial transformation, particularly within the high-impact electronics sector. Its unique value lies in the integration of real-world industry insights, regional benchmarking, and empirical validation, all framed within a policy-relevant structure. The study's key contributions are outlined below:

1.6.1 Integrated Three-Pillar Framework

The most significant contribution of this study is its development of a holistic analytical framework that examines Malaysia's electronics industry through three interconnected pillars: Innovative Performance (IP), Talent Management (TM), and Regulatory Environment (RE). This integrated approach recognizes that these elements do not exist in isolation but rather form an ecosystem where weaknesses in one area affect performance across the entire industry. By applying the Resource-Based View (RBV) framework to analyze how these factors collectively impact firm performance, the study provides a more nuanced understanding than previous sector analyses that often treated these challenges separately.

1.6.2 Evidence-Based Case Study Analysis

The paper makes an exceptional contribution through its compilation of ten detailed, real-world case studies that provide concrete evidence of both challenges and opportunities within Malaysia's electronics sector. These range from technological adoption cases (GaN technology, AI, quantum computing) to talent-related issues (engineering shortages, brain drain) and regulatory hurdles. This approach grounds theoretical discussions in practical realities, making the findings particularly valuable for industry stakeholders and policymakers.

1.6.3 Integration of Qualitative and Quantitative Evidence

The paper uniquely blends qualitative case studies which grounded in real Malaysian firm experiences with quantitative analysis based on the Resource-Based View (RBV) framework and Partial Least Squares Structural Equation Modelling (PLS-SEM). This mixed-methods approach strengthens the validity of the findings and provides multiple perspectives on the challenges facing the industry. This integration bridges the gap between policy narratives and data-driven strategy, offering both credibility and clarity in assessing which interventions will yield the highest impact.

1.6.4 Policy-Relevant, Actionable Recommendations

Unlike traditional academic studies, this position paper delivers targeted policy interventions tailored to Malaysia's current economic development plans, such as the New Industrial Master Plan (NIMP) 2030. The recommendations which ranging from centralized R&D hubs to talent repatriation incentives and digital regulatory platforms, are aligned with global best practices and provide a direct blueprint for implementation.

1.6.5 Adaptation of Global Best Practices to Local Context

Drawing from successful models in Singapore, South Korea, Thailand, and Vietnam, the paper identifies strategies that have worked in other advanced electronics ecosystems. Importantly, these lessons are contextualized to fit Malaysia's institutional capacities, workforce demographics, and industrial priorities that making them more feasible and sustainable in local implementation.

1.6.6 A Roadmap for Stakeholder Alignment and Industrial Policy Reform

By articulating a Strategic Roadmap in its final chapter, the paper not only diagnoses issues but offers a structured path forward. This roadmap is designed to align the efforts of government agencies, industry players, academic institutions, and regulatory bodies toward a common vision: establishing Malaysia as a globally competitive, innovation-driven electronics hub.

1.7 Paper Contribution

This study makes three distinctive contributions. First, it advances the resource-based view in an emerging-economy, high-tech setting by integrating innovation capacity (IP), talent management (TM), and the regulatory environment (RE) into a single, empirically tested framework for Malaysia's E&E sector, an integration not previously validated in this context. Second, it offers mixed-methods triangulation that links 11 practitioner-validated case studies to a survey of industry decision-makers (N=71) analysed with PLS-SEM, introducing context-specific measures for IP, TM, and RE and showing that innovation capacity has the strongest

and statistically significant association with firm performance, while talent and regulation exhibit positive but weaker/marginal effects. Third, it translates the evidence into a sequenced, implementable policy roadmap, R&D hubs and consortia, SkillsMalaysia-style upskilling, and a digital one-stop regulatory model—thereby bridging academic analysis with actionable industrial policy. Collectively, the study moves the debate beyond descriptive diagnostics by providing a validated model, new measurement instruments, and a prioritized set of interventions that stakeholders can use to track progress and evaluate impact over time.

1.8 Conclusion

Malaysia's ambition to become a global powerhouse in the electronics industry hinges not only on its current strengths, but on its ability to proactively address the evolving demands of a high-tech, innovation-led economy. This chapter has outlined the rationale, objectives, and structure of the position paper, setting the stage for a comprehensive analysis of the critical factors affecting firm performance across the electronics value chain.

By focusing on three key dimensions: Innovative Performance (IP), Talent Management (TM), and the Regulatory Environment (RE), the paper aims to offer a practical and evidence-backed roadmap for policy transformation. Drawing on successful models from leading economies and grounded in both qualitative and quantitative evidence, this study serves as both a diagnostic tool and a strategic guide for enhancing national competitiveness.

The subsequent chapters will delve deeper into the challenges currently limiting Malaysia's progress, provide rich contextual insights through case studies, and present robust, data-driven justifications for the policy interventions recommended. Together, these chapters form a cohesive argument that now is the time for bold, coordinated action. With the right strategic reforms, Malaysia's electronics industry can not only overcome its current constraints but rise as a regional and global leader in innovation, talent, and technology governance.

2 Introduction

2.1 Background and significance of the study

Malaysia's electronics industry encompassing semiconductors, electronic components, and consumer electronics, is a cornerstone of the national economy. In recent years, the electrical and electronics (E&E) sector has contributed approximately five to six percent of Malaysia's GDP and close to 40% of the country's exports (MITI, 2023a; MITI, 2024). In 2022 alone, E&E exports reached about RM593 billion, accounting for 38% of Malaysia's total export value (MIDA, 2023a & 2021; DOSM, 2021; MATRADE, 2023). The industry also generates substantial trade surpluses (about 78% of Malaysia's net trade surplus) and attracts significant investments, exemplified by a record RM148 billion in manufacturing investment in 2021 (DOSM, 2021; MIDA, 2022). Employment in the E&E sector exceeds half a million Malaysians that is roughly 590,000 direct jobs, with millions more employed indirectly through supporting industries (MITI, 2023b). Malaysia has become a key player in global supply chains, accounting for about seven percent of global semiconductor trade (ISIS, 2024) and roughly 13% of the world's semiconductor packaging and testing market (MIDA, 2024).

Within Malaysia, the state of Penang plays an outsized role as an industrial hub for electronics. Often dubbed the "Silicon Valley of the East," Penang has built on five decades of industrial success to host numerous multinational electronics firms since the 1970s (InvestPenang, 2020). The state's robust ecosystem now accounts for a significant share of output and trade that make up Penang's export channels handled nearly 30% of Malaysia's exports in the first half of 2023 (The Malaysian Reserve, 2025). Thanks to its strong E&E cluster, Penang alone is estimated to contribute over 7% of the world's semiconductor sales (InvestPenang, 2023). This leadership is reinforced by steady investment inflows: in 2022 Penang attracted RM13.7 billion in approved manufacturing investments (about 16% of Malaysia's total), which are expected to create over 15,700 new jobs in the state (MIDA, 2023b). Foreign direct investments made up the bulk of these projects, reflecting investor confidence in Penang's conducive business environment and skilled workforce.

Despite these strengths, Malaysia's electronics industry faces critical challenges in innovation and competitiveness. One concern is the relatively low investment in research and development (R&D) and limited indigenous innovation. Malaysia's R&D expenditure has hovered around 1% of GDP in recent years (about 1.06% in 2021) (UNESCO, 2021), which lags far behind innovation leaders like South Korea (over 4.9% of GDP) (OECD, 2023). Consequently, Malaysia's innovation outputs remain modest on the global stage for example, the country ranked 36th in the Global Innovation Index 2022 (WIPO, 2022), below several regional peers. Industry observers note that the electronics sector still leans heavily on foreign technology and is concentrated in mid-value manufacturing, with comparatively fewer activities in upstream chip design or downstream product development.

Another pressing issue is the talent pipeline and workforce development for the E&E ecosystem. The sector's rapid growth has outpaced the supply of qualified engineers and technicians. According to MITI, the electronics industry currently needs about 50,000 skilled engineers, yet local universities produce only around 5,000 engineering graduates per year to fill this demand (BERNAMA, 2024a). Moreover, enrollment in STEM fields has been declining, exacerbating future talent shortages (Malay Mail, 2024a). Malaysia's talent gap is further widened by brain drain that estimated 500,000 highly skilled Malaysians were working overseas as of 2020 (The Sun Daily, 2022; World Bank, 2020). This outflow of expertise puts pressure on the domestic talent pool, forcing companies to either train fresh graduates or automate and outsource more functions.

The regulatory environment is another determinant of competitiveness in Malaysia's electronics industry. Malaysia ranked 12th out of 190 economies for overall ease of doing business in the World Bank's Doing Business 2020 report (World Bank, 2020). Specific to manufacturing and technology, policies such as the Industrial Master Plan series and the recent National Investment Aspirations framework aim to simplify tax incentives and approval processes for high-tech projects. Additionally, the Industry4WRD policy launched in 2018 provides a roadmap for digital transformation of manufacturing (MITI, 2018), and the new National Industrial Master Plan 2030 (NIMP 2030) sets out mission-based initiatives to develop advanced industry clusters including E&E (MITI, 2023b). However, several regulatory challenges persist, such as bureaucratic delays in permits, overlapping compliance requirements, and inconsistent implementation at state levels.

In summary, Malaysia's E&E industry is highly significant and globally integrated, yet it faces capability gaps in innovation, human capital, and regulatory agility. To sustain its position and advance further, Malaysia must not only benchmark itself against peers such as Singapore, South Korea, and Vietnam, but also address its unique challenges through targeted interventions.

2.2 Objectives and Scope

2.2.1 Objectives of the Position Paper

The primary objective of this position paper is to examine how government interventions in Innovative Performance (IP), Talent Management (TM), and the Regulatory Environment (RE) can improve firm performance in Malaysia's electronics sector (with a particular focus on Penang's industrial ecosystem). To achieve this, the study adopts a mixed-method approach comprising: (a) exploratory qualitative case studies to identify key determinants of firm performance, and (b) a confirmatory quantitative analysis based on the RBV framework to test the influence of those determinants on performance outcomes. By integrating these methods, the paper aims to provide a robust basis for policy recommendations.

Specifically, the position paper seeks to:

1. **Explore Determinants of Firm Performance:**
   Utilize qualitative case studies of firms and initiatives in the electronics sector to identify the factors (within IP, TM, and RE) that most significantly impact firm performance. This exploratory phase will surface real-world issues such as specific innovation bottlenecks, talent shortages, and regulatory hurdles faced by companies.

2. **Confirm Determinants Using the RBV Framework:**
   Conduct a quantitative analysis (survey-based) to evaluate the influence of the identified factors on firm performance. Guided by RBV theory, the following hypotheses are tested:
   - **H1: Innovative Performance (IP)** has a positive impact on firm performance (FP). Firms that excel in product/process innovation and technology adoption are hypothesized to achieve higher sales growth, profitability, and market share.
   - **H2: Talent Management (TM)** effectiveness enhances firm performance. Firms with stronger talent development, recruitment, and retention practices are expected to have greater productivity and innovation output, leading to better performance.

- **H3: Regulatory Environment (RE)** has a significant influence on firm performance. A supportive regulatory framework that characterized by efficient procedures, fair competition policies, and consistent enforcement. It is hypothesized to correlate with improved operational efficiency and competitiveness of firms.

3. Propose Actionable Government Interventions:

Based on the insights from (1) and (2), offer practical and evidence-based recommendations for the Penang state government and federal authorities. These interventions will target improvements in IP, TM, and RE (such as new innovation funding programs, education reforms, or regulatory streamlining initiatives) with the goal of enhancing firm performance and fostering sustainable growth of the electronics industry.

2.2.2 Scope of Position Paper

This paper focuses on Malaysia's electronics sector, with particular emphasis on the dynamic ecosystem in Penang, which is illustrative of the country's electronics industry capabilities and challenges. The scope encompasses the three core areas (IP, TM, RE) deemed pivotal to firm-level competitiveness and industry sustainability:

- **Innovative Performance (IP):** The paper examines R&D activities, technology adoption, and innovation culture within firms. It explores how Malaysia can enhance innovation. For example, by fostering industry-academia collaboration, supporting emerging technologies like Gallium Nitride (GaN) semiconductors and AI, and learning from international benchmarks. Recent developments such as Malaysia's involvement in GaN epitaxy programs through Collabourative Research in Engineering, Science & Technology (CREST) indicate a growing focus on high-tech R&D. The scope includes studying such initiatives and their impact, as well as identifying gaps (e.g., commercialization challenges, limited private R&D spending).
- **Talent Management (TM):** The analysis addresses the talent pipeline issues, including the limited supply of electrical and electronics (E&E) engineering graduates, declining student interest in STEM fields, and the ongoing "brain drain" of experienced professionals. It evaluates existing government and industry-led talent development programs (e.g., TalentCorp initiatives, university curricula, vocational training centers) and considers new strategies to bolster human capital. The scope is limited to workforce issues specific to the electronics/E&E industry, and it does not extend to general labour market or brain drain issues outside this sector.
- **Regulatory Environment (RE):** The paper assesses how Malaysia's regulatory and policy framework affects electronics firms. Key issues include bureaucratic red tape (e.g., slow permit approvals, customs delays), inconsistent import/export regulations, and the increasing demand for compliance with international standards such as the Responsible Business Alliance (RBA) code of conduct and environmental regulations. The scope covers national and state-level regulations that directly impact the electronics manufacturing and R&D operations (e.g., investment incentives, environmental laws, trade facilitation, education policies). Broader macroeconomic policies and global trade agreements are outside the scope, except where they directly relate to the electronics industry's regulatory context

The geographical scope is primarily Malaysia. However, comparative insights are drawn from other Asian economies (Singapore, Thailand, Vietnam, South Korea, etc.) to benchmark practices and outcomes. The time frame of analysis centers on the current state and near-future

outlook (circa 2020–2025) with foresight towards Malaysia's goals for 2030 as outlined in national strategies like the New Industrial Master Plan (NIMP 2030).

The recommendations derived in this paper are tailored to Malaysia's context but may also hold relevance for other emerging economies aiming to upgrade their electronics or high-tech industries. Conversely, the paper excludes analysis of macroeconomic variables (exchange rates, global demand shocks, trade war) and broader socio-political factors, to maintain focus on the interplay between innovation, talent, regulation, and firm performance within the industry.

2.3 Chapter Conclusion

In summary, Chapter 2 has established the foundational context and objectives of this study. Malaysia's electronics sector is a major driver of economic growth and a source of national pride, yet it confronts serious challenges that could hinder its trajectory if left unaddressed. Key issues identified include **innovation gaps** (limited R&D and slow tech adoption), **talent shortages** (mismatch between industry needs and workforce skills, brain drain), and **regulatory inefficiencies** (bureaucracy and misalignment with global standards). Using the Resource-Based View framework, we argue that these internal factors (innovation capability, human capital, regulatory compliance capacity) are crucial resources that determine firm performance and competitive advantage.

The chapter also underscored the critical role of Penang as a leading hub within Malaysia's electronics industry. From Penang's experience, its success in attracting MNCs and clustering suppliers, as well as its struggles with sustaining talent and moving up the value chain which provides valuable lessons that can inform national-level strategies. By aligning our research objectives with both global best practices and local realities, this paper aims to fill knowledge gaps and suggest targeted interventions to overcome the identified barriers.

The next chapters will delve deeper into these themes. Chapter 3 will articulate the problem statement in detail, framing the specific challenges in IP, TM, and RE that our analysis will tackle, and explain why government action is needed. Subsequent chapters will then present empirical findings and recommendations. In moving forward, the narrative will maintain a clear line of argument: from diagnosing the problems, to analyzing underlying causes and effects, to formulating solutions. This structure ensures that the study not only identifies critical issues but also provides a logical, evidence-backed roadmap for policymakers to bolster Malaysia's electronics industry.

Problem Statement

3.1 An Overview about Challenges in the Malaysian Electronics Sector

Malaysia's electronics sector is a vital component of the national economy, but it is currently facing several critical challenges that threaten its competitiveness and long-term sustainability. These challenges manifest in three interrelated domains: Innovative Performance (IP), Talent Management (TM), and the Regulatory Environment (RE). Each domain encompasses specific issues, outlined in sub-sections 3.1.1 through 3.1.3 below. Identifying these issues clearly is essential for developing solutions, as they represent the key problem areas that government policies and industry efforts need to address.

3.1.1. Challenges in Innovative Performance (IP)

Innovation is often described as the lifeblood of the electronics industry. The ability to design new products, improve processes, and adopt cutting-edge technologies determines whether firms can move up the value chain and maintain competitive advantage. In Malaysia, however, firms face several impediments to innovation:

- **Limited R&D Investment:** Many electronics firms, particularly domestic SMEs, invest only minimally in research and development. Malaysia's R&D expenditure as a percentage of GDP has historically lagged behind that of innovation-driven economies. This under-investment means fewer new product developments and a reliance on aging product lines. Companies with tight margins struggle to finance research or acquire expensive new equipment, and government funding schemes, while present, are often not large or agile enough to fill the gap. For example, in interviews one SME manager noted that they had many ideas for automation but no budget to prototype them. Lack of R&D financing constrains firms' ability to innovate and stay ahead of global competitors.
- **Weak Industry–Academia Collaboration:** Effective innovation often arises from collaboration between industry and research institutions (universities or public research agencies). In Malaysia's electronics sector, such partnerships have not reached their full potential. There is a **gap between academic research and commercial application** – universities may conduct relevant research (e.g., on novel semiconductor materials or AI algorithms), but mechanisms to transfer those findings into industry are limited. Companies report difficulty in accessing local academic expertise for problem-solving, while academics cite a lack of industry grants or data sharing. This weak linkage results in underutilization of local knowledge assets and forces firms to depend on foreign technology.
- **Insufficient Innovation Culture:** Beyond tangible investments, **organizational culture** plays a role. Many firms, especially established ones, focus on short-term production targets and cost efficiency at the expense of experimentation and long-term innovation. Risk-taking is often not encouraged; employees may not feel empowered to propose or try out new ideas. This cultural aspect is partly historical (firms growing as contract manufacturers with predefined processes) and partly due to resource constraints (tight deadlines leave little room for exploratory projects). As a result, the industry lacks a robust innovation pipeline, and firms may respond slowly to technological shifts. Encouraging a mindset of continuous improvement and creativity is a soft challenge that is hard to quantify but critical to address.

Taken together, these issues result in Malaysia's electronics firms often being technology followers rather than leaders. For instance, in emerging areas like advanced sensors, IoT devices, or novel chip materials, Malaysian firms have been slow to engage compared to

competitors in South Korea or Taiwan. Strengthening innovation capacity is thus a central challenge.

3.1.2. Challenges in Talent Management (TM)

Malaysia, a diverse and vibrant country in Southeast Asia, has been making significant strides in talent development. With a rapidly growing economy and a strong emphasis on Electrical and Electronics (E&E) industry, Malaysia recognizes the crucial role that talent plays in driving its development and global competitiveness. The success of any industry depends heavily on its human capital, and the EEs sector is no exception. However, the industry faces significant challenges in managing and retaining talent, which are critical to maintaining productivity and innovation:

- **Shortage of Skilled and Experienced Workforce:** There is a growing mismatch between the **skills demanded** by the modern electronics sector and those available in the local labour market. The industry increasingly needs experts in semiconductor design, automation engineering, data science, and other high-tech areas. However, many firms report difficulty in hiring for these roles domestically. Experienced professionals (with 5-10 years in advanced engineering or R&D roles) are especially scarce. This talent shortage forces companies to either hire expatriates (which can be costly and involve work permit hurdles) or limit their project scope due to manpower constraints. It also puts upward pressure on wages for the limited pool of experts, which SMEs may struggle to afford.
- **Limited Supply of EE Graduates**: Malaysia's universities produce engineering graduates, but not in sufficient numbers for the electronics industry's needs, particularly in electrical and electronics (E&E) and related fields. Enrollment in E&E programs has not kept pace with industry growth. One recent report noted that Malaysia would need an additional 20,000 E&E engineers in the next few years, yet current graduation rates fall short. Furthermore, quality and specialization are concerns whereas the graduates often lack practical skills or specialization in niche but important areas (for example, microelectronics fabrication or integrated circuit design). This talent gap poses a critical barrier to innovation and competitiveness, highlighting an urgent need for enhanced educational initiatives and industry-academia coordination to produce job-ready graduates.
- **Declining Interest in STEM Careers:** A worrying trend is the declining interest among Malaysian youth in pursuing STEM (Science, Technology, Engineering, Mathematics) education and careers. Over the past decade, there have been numerous reports about lower student uptake in physics, math, and engineering streams. This decline threatens the future availability of skilled engineers and technicians. If fewer top students choose engineering or computer science, the pipeline of talent for the electronics industry will continue to shrink. The causes include perceptions that engineering is difficult or less lucrative compared to fields like business or medicine, as well as lack of awareness about the exciting opportunities in tech. Reversing this trend requires concerted efforts to inspire and attract young talent to E&E careers (for instance, through STEM promotion campaigns, scholarships, robotics competitions in schools, etc.). Without such efforts, Malaysia risks a structural talent deficit in its high-tech sectors.
- **Brain Drain of Top Talent:** Malaysia has long experienced "brain drain", the emigration of highly skilled professionals to other countries (Singapore, Australia, the US, etc.) in search of better opportunities. In the electronics sector, this means some of the best engineers, managers, or researchers Malaysia educates end up contributing to foreign economies. This brain drain depletes the local talent pool at the mid-career and

senior levels, making it difficult for domestic firms to find top-tier expertise or leadership. One recent statistic indicated Malaysia's skilled migration rate is significantly higher than the global average. The drivers include higher salaries abroad, more advanced R&D facilities, and sometimes quality-of-life factors. While some level of international talent mobility is normal, excessive brain drain can stunt the development of domestic capabilities. This challenge underscores the need for talent retention strategies, such as improving local career prospects, recognizing and rewarding talent, and perhaps leveraging the diaspora network to continue contributing knowledge back to Malaysia.

- **Talent Retention and Development Issues:** Even within firms, retaining talent is a challenge. Competitive compensation, clear career advancement paths, and work-life balance are crucial for retention. Many firms, especially SMEs, struggle to provide these, leading to high turnover rates and loss of institutional knowledge. Additionally, ongoing professional development is sometimes lacking whereas the engineers may not receive continuous training to update their skills in fast-evolving fields. Without systematic upskilling, even currently competent workers may become less relevant as technology progresses (e.g., an equipment technician might need training in programming to handle new automated machinery). Addressing retention requires both company-level practices and supportive policies (like programs to subsidize training or encourage mentorship)

In sum, the talent management challenges can be seen as a pipeline problem (that insufficient new talent coming in) and a maintenance problem (that not keeping and growing the talent we have). Solving these will involve education reforms, better alignment between educational institutions and industry needs, and policies to make Malaysia an attractive place for skilled workers.

3.1.3. Challenges in the Regulatory Environment (RE)

A supportive regulatory environment is critical for creating a stable and predictable business climate that fosters growth and innovation in the electronics sector. However, several regulatory challenges in Malaysia impact the industry's supply chain and overall value chain efficiency. These challenges include bureaucratic inefficiencies, import-export uncertainties, and evolving supply chain transparency requirements, all of which hinder operational effectiveness and competitiveness. The value chain of the electronics industry is illustrated as in Figure 3.1:



Figure 3.1: New Investment Policy (NIP) (National Industrial Master Plan (NIMP) 2030, 2023))

In Malaysia, the government has introduced various policies to support the electronics industry over the years. However, companies still face several regulatory and bureaucratic challenges:

- **Bureaucratic Red Tape:** Complex and **inefficient administrative processes** remain a concern. Firms often encounter delays in obtaining necessary permits, licenses, or approvals for operations and expansions. For example, environmental approval for

factory expansion or the certification of new electronic components can be slow, involving multiple agencies (e.g., local councils, Department of Environment, SIRIM standards body). These delays increase operational costs and uncertainty. In one instance, an electronics materials supplier reported significant losses when a newer grade of aluminum, already globally adopted, was held up at Malaysian customs due to outdated standards at the agency responsible for inspection. The material sat in port while paperwork lagged, disrupting not only the supplier but also downstream electronics manufacturers waiting on that input. Such bureaucratic hurdles reduce Malaysia's attractiveness for investment compared to more agile business environments in the region.

- **Uncertainty in Trade Controls: Import and export procedures** in Malaysia, while generally rules-based, can sometimes be unpredictable or inconsistently enforced. Companies have noted instances of sudden changes in tariff classifications or ad-hoc import clearance requirements. On the import side, unclear guidelines on duties or documentation mean firms sometimes only discover additional costs or requirements when goods are already at customs. SMEs, lacking dedicated trade compliance teams, are particularly vulnerable to these uncertainties which can disrupt their supply chains. On the export side, compliance with international export regulations (such as U.S. export controls on certain semiconductor technologies) adds complexity, and firms must also navigate Malaysia's own export documentation. While larger MNCs can manage this (often having compliance departments), smaller firms find it onerous. Inconsistent application of rules (e.g., varying interpretations by different officers or ports) further exacerbates the issue. Uncertainty and administrative burdens in trade increase lead times and costs, which is problematic in an industry that relies on fast turnaround and global integration.
- **Evolving ESG and Transparency Standards:** Globally, there is a trend toward requiring greater **supply chain transparency** and adherence to environmental, social, and governance (ESG) standards. Malaysian electronics exporters, especially those supplying to EU or U.S. customers, face pressure to document their supply chain practices (e.g., no conflict minerals, fair labour, low carbon footprint). However, Malaysia's domestic regulations and guidelines in these areas are still catching up. Companies often lack clear local directives on how to measure or report ESG metrics. For instance, if an EU customer asks a Malaysian circuit board producer to prove compliance with the EU's Carbon Border Adjustment Mechanism (CBAM) (which effectively means tracking carbon emissions in production), the producer may not have guidance from Malaysian authorities on standards or reporting methods. Similarly, while Malaysia has environmental laws, enforcement of industrial waste and emissions standards can be inconsistent, which may lead to future risk if international partners demand proof of compliance. **Responsible Business Alliance (RBA)** standards (covering labour conditions, safety, etc.) are not legally mandated in Malaysia, so firms adopt them voluntarily or at a customer's insistence. This patchwork of evolving global requirements without a strong domestic framework leaves firms uncertain about how to proceed, and those that proactively invest in compliance face higher costs without an even playing field across the industry.
- **Outdated Regulations and Standards:** Technology often moves faster than regulation. Some of Malaysia's standards and regulations have not been updated in line with technological advancement. For example, legacy regulations might classify certain high-tech materials or chemicals in outdated categories, causing delays as mentioned. Regulations around emerging areas like **fintech, autonomous systems, or even novel manufacturing techniques (e.g., 3D printing of electronics)** are still nascent,

potentially hindering firms that want to experiment in these areas. Additionally, corporate regulations (like business registration, foreign ownership rules, etc.) while much improved in recent years, can still be cumbersome for startups or new business models in the electronics field (such as companies offering "hardware-as-a-service" or other non-traditional arrangements). In essence, regulatory agility is sometimes lacking.

- **Global Alignment and Market Access:** As international regulations (like Europe's environmental directives or the U.S. CHIPS act) evolve, Malaysian policies must adapt to ensure local firms are not locked out of key markets. A challenge is that Malaysian regulatory bodies need to actively monitor and respond to these external policy changes. If, for instance, the EU requires all electronics imports to declare carbon content by 2025 and Malaysia does not have a system for that, Malaysian exporters could be disadvantaged. Aligning local regulations with global standards (on safety, quality, data security, etc.) is resource-intensive but crucial for market access. Firms sometimes feel they are navigating this alone; a more structured government roadmap on meeting global compliance (like ISO certifications, etc.) would help.

The **implications** of these regulatory challenges are significant: increased compliance costs, delays in operations, and in worst cases loss of business opportunities. SMEs again are disproportionately affected, as they have fewer resources to handle bureaucratic burdens or to dedicate to compliance activities. In aggregate, such challenges can erode Malaysia's competitiveness as an investment destination for electronics manufacturing relative to countries that have more business-friendly environments.

Addressing these issues requires the government to streamline and modernize processes (e.g., through digitization and single-window services), improve inter-agency coordination, and proactively engage with industry to update regulations in line with technological changes. Positive steps are underway (for example, the Malaysia Productivity Corporation has been tasked with reducing unnecessary regulations, and there is discussion of regulatory sandbox frameworks), but consistent implementation is key.

A specific example highlights these issues: Figure 3.2 below conceptually illustrates how different parts of the electronics industry value chain are affected by regulatory hurdles, from importing raw materials to exporting finished goods. Bureaucratic delays can cause bottlenecks at multiple points. This figure, from the National Investment Plan, emphasizes the need for policy reform at each stage.

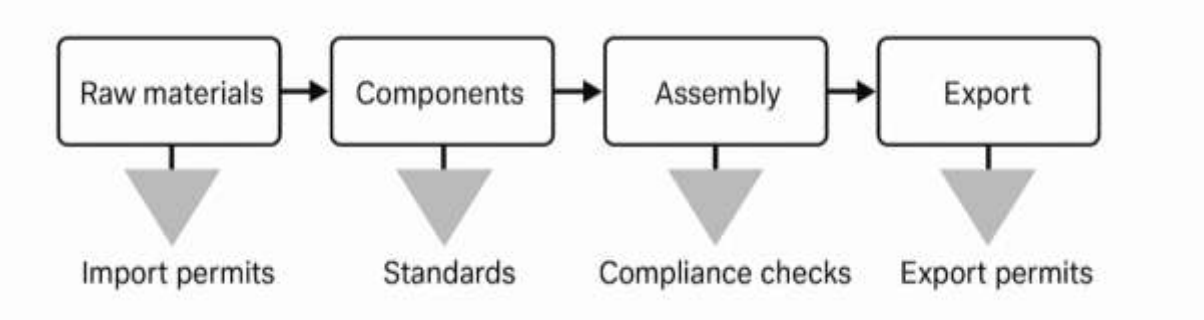


Figure 3.2: Schematic of Malaysia's Electronics Value Chain and Points of Regulatory Intervention.

Implications for the Electronics Sector

The challenges in IP, TM, and RE discussed above pose significant obstacles to growth. If unaddressed, they could lead to: higher production costs, slower innovation cycles, difficulty in moving up the value chain, and a potential decline in Malaysia's share of global electronics exports. Already, neighboring countries are aggressively improving their ecosystems (e.g., Vietnam investing in STEM education and courting chipmakers, or Thailand developing innovation hubs). Malaysia must tackle these internal issues to maintain and enhance its position.

In summary, Malaysia's electronics sector faces a convergence of innovation, talent, and regulatory challenges. These are not isolated silos whereas they have interacted each other. For instance, outdated regulations can exacerbate the brain drain (if talent perceives fewer cutting-edge opportunities locally), or talent shortages can hamper innovation. This interplay means solutions must be coordinated as well. The next section will argue why government intervention is not only beneficial but necessary to address these challenges holistically.

3.2 Importance of government interventions in Innovative Performance (IP), Talent Management (TM), and the Regulatory Environment (RE)

The government plays a crucial role in addressing the challenges outlined in the problem statement for several reasons:

a) **Strategic Resource Allocation:** Only the government can mobilize and direct resources at the scale required to significantly improve innovation infrastructure and education systems. Through its policies and budgets, the government can channel funding to where it's most needed. For example, providing R&D grants or tax incentives to encourage private innovation investment. Individual firms, especially smaller ones, might not undertake risky, long-term R&D on their own, but a well-designed government matching grant or public research initiative can stimulate such innovation. In the context of Malaysia, initiatives like MOSTI's technology funds or tax breaks in the annual budget for high-tech projects are tools to spur IP improvements. Similarly, scholarships and training subsidies can be allocated to address talent gaps (e.g., sponsoring students in semiconductor physics or sending lecturers for upskilling). Government's ability to take a long-term view and bear risk (where private actors might not) is vital in innovation and skills development which have long payoff periods (Goh and Tang, 2024; BusinessToday, 2024).

b) **Regulatory Oversight and Reform:** The government is responsible for the regulatory environment in which firms operate. As highlighted, issues like red tape or outdated rules are inherently under government's purview to fix. Streamlining regulations (for instance, by simplifying permit procedures or adopting international standards swiftly) often requires coordination across multiple agencies and ministries, a task that only a central authority can manage. A proactive government approach to regulation can reduce uncertainty and cost for firms, effectively "unlocking" some of the constraints on performance. Without government intervention, firms are essentially stuck with the status quo rules, which we've identified as suboptimal. Moreover, fair competition laws, intellectual property protection, and ease of doing business are all areas where government sets the tone. If enforcement is inconsistent or laws are outdated, firms cannot change that on their own. It needs policy action. Therefore, government leadership in regulatory reform is essential to create an enabling environment for innovation and investment.

c) **Education and Talent Development:** The education system and national labour policies are largely governed by the state (through the Ministry of Education, Ministry

of Human Resources, etc.). To address talent shortages, government intervention is critical at multiple levels: revamping curricula, investing in technical education facilities, and running national campaigns to promote STEM. For example, incorporating industry needs into university programs often requires policy changes or incentives (such as the Public-Private Research Network programs). Additionally, the government can implement policies to retain talent, like bonding scholarship students to work in-country for a few years, or offering returning scientist schemes. Malaysia's government has indeed recognized some of these needs via the Malaysia Education Blueprint 2013–2025 calls for enhancing STEM education, and agencies like TalentCorp have programs to address critical occupation shortages. However, the effectiveness of these depends on continual support and refinement. State governments (like Penang's) can also play a role by working with local industries and educational institutions. In short, because talent development has public good characteristics (no single company will train workers only to possibly lose them to others), government coordination and funding are needed to ensure a robust talent pipeline. This includes collabourating with educational institutions to align curricula with industry needs and offering scholarships or incentives to retain talent within the country (MIDA, 2021).

d) **Catalyzing Collaboration:** Many of the challenges at hand sit at the intersection of multiple stakeholders: firms, universities, government bodies, and even other countries (for technology and markets). The government can act as a facilitator of collaboration. One clear example is in R&D: a government-backed consortium or platform can bring together companies and researchers to work on pre-competitive technologies (like a next-gen chip design) that benefit the whole industry. Without such facilitation, firms might not collaborate due to competitive concerns or coordination failures. Similarly, public institutes or initiatives (like CREST in Malaysia or Thailand's National Innovation Agency) can coordinate PPPs (public-private partnerships) that share knowledge and cost. Government ministries can also help connect industry needs with university research agendas (e.g., through grant calls targeting specific industry problems). The cluster development in Penang historically benefited from government setting up free trade zones and then letting industry form networks. Now, the next step might involve more knowledge-driven collaboration, which again government can spark (by establishing an Electronics Center of Excellence or funding collabourative labs). In talent, government can partner with industry to run apprenticeship or "teach for industry" programs. The government's convening power is unique because it can bring all relevant parties to the table to address systemic challenges that no single firm could tackle alone.

e) **Ensuring Economic Stability and Strategic Growth:** Beyond the immediate interests of firms, the government's broader mandate is national economic development. The electronics sector is a strategic industry for Malaysia's future as identified in plans like NIMP 2030. Government intervention is thus also about ensuring this sector continues to contribute to economic stability (jobs, exports) and becomes a driver of future growth (through moving up value chains). By intervening in IP, TM, and RE challenges, the government can help the electronics industry attract foreign direct investment in higher-tech areas, enable local companies to become global suppliers, and increase resilience to external shocks. For instance, by improving the regulatory climate, Malaysia could attract a major semiconductor fab investment that might otherwise go to a competitor country. By building talent, it could convince a global tech firm to set up an R&D center in Kuala Lumpur or Penang. These outcomes have multiplier effects on the economy (more high-paying jobs, knowledge transfer, etc.) which justify government action. Conversely, if the government were hands-off and these challenges persist, the risk is

that the electronics sector could stagnate or even decline relative to global peers, which would hurt the country's economic prospects.

In summary, government intervention is indispensable for overcoming the current challenges in Malaysia's electronics industry. Market forces alone may not resolve issues like underinvestment in R&D or talent shortages. In fact, they could worsen if firms continue to underinvest or if talent keeps emigrating. The government's role is to provide strategic direction, reduce hurdles, and invest in public goods that support the industry. Indeed, many of the success stories internationally (such as South Korea's rise in semiconductors or Singapore's thriving electronics sector) were enabled by active government policies and institutions supporting those industries. Malaysia's situation similarly calls for bold and targeted government action.

3.3 Chapter Conclusion

Chapter 3 has outlined the critical challenges confronting Malaysia's electronics sector across three core dimensions: IP, TM, and RE and argued for the necessity of strategic government intervention. In summary:

1. **Innovative Performance (IP):** Firms face barriers such as low R&D spending, insufficient industry-academia linkages, and a short-term oriented business culture that hampers innovation. These limit the development of new products and processes, thereby restricting growth and competitiveness. The government's role in mitigating these issues (through funding and fostering collabourative innovation ecosystems) is crucial to elevate the sector's innovation output.
2. **Talent Management (TM):** A shortage of skilled engineers and technicians, coupled with declining STEM interest and brain drain, has led to a significant talent gap. This affects productivity and the ability of firms to undertake complex projects. Government-led educational reforms, training incentives, and talent retention programs are needed to build a robust talent pipeline and ensure a sustainable workforce for the electronics industry.
3. **Regulatory Environment (RE):** Bureaucratic inefficiencies, outdated regulations, and emerging ESG compliance demands impose extra costs and uncertainties on electronics firms. Without regulatory improvements, firms (especially SMEs) struggle to operate efficiently and integrate into global supply chains that require high standards. Government intervention to streamline processes and update regulatory frameworks will directly improve the ease of doing business and the sector's global integration.

These challenges are interlinked and collectively impact the industry's growth, competitiveness, and sustainability in the global market. The chapter highlights an urgency: if Malaysia does not address these issues promptly, it risks falling behind in the very areas (innovation, skills, advanced manufacturing practices) that determine future success in the electronics arena.

Encouragingly, the Malaysian government has recognized many of these issues in policy dialogues and has initiated steps (such as the latest national digital and IR4.0 policies, talent development programs, etc.). However, the analysis here underscores that more concerted and integrated actions are required. The challenges must be tackled through a coordinated strategy that involves government agencies, industry stakeholders, and educational institutions working together.

This conclusion serves as a bridge to the subsequent chapters. With the problems clearly defined, the paper now transitions to analytical sections that explore these challenges in depth and seek evidence-based solutions:

- In **Chapter 4**, we will explore real-world *case studies* and data from Malaysia's electronics industry to illustrate the challenges and also identify any bright spots or opportunities (the "opportunities" aspect) that can be leveraged. The qualitative insights from these cases will enrich our understanding beyond the broad strokes painted in this problem statement, by providing concrete examples and expert perspectives on IP, TM, and RE issues.
- In **Chapter 5**, drawing from both the problem analysis and case insights, we will propose actionable recommendations. These will be mapped to the challenges identified, ensuring that each major issue is addressed by one or more specific strategies, aligned with international best practices and tailored to Malaysia.
- In **Chapter 6**, we will quantitatively assess the expected impact of these interventions on firm performance, using the survey and RBV framework. This will validate (or refine) our understanding of which factors matter most and how much improvement might be achieved if the recommendations are implemented, thus tying the interventions back to performance outcomes.
- Finally, **Chapter 7** will provide an overall conclusion and a strategic roadmap for implementation, reiterating the key findings and laying out immediate and medium-term steps for stakeholders.

By following this structure, the paper ensures that we maintain a clear line of sight from problems to solutions to outcomes. Having established *why* government action is needed and *what* problems to solve, we now move on to examine *how* these problems manifest in practice and *how* they can be solved.

4 Challenges and Opportunities in Malaysia's Electronics Industry

Malaysia's electronics industry is at a crucial juncture, facing significant challenges as outlined, but also holding notable opportunities for transformation and growth. In this chapter, we use case studies to delve into specific examples that highlight these challenges and potential opportunities in the areas of innovation (IP), talent (TM), and regulation (RE). Each case study focuses on a particular facet of the ecosystem, supported by input from subject matter experts (SMEs) or real incidents, to provide empirical grounding for our analysis. The case studies serve a dual purpose: they illustrate the problems identified (making them more tangible), and they reveal where interventions have worked or could work (pointing to opportunities and best practices). Key factors like innovative performance, talent management, and the regulatory environment are vital for maintaining its global position (see Figure 4.0.1). This section explores these areas through case studies that highlight the industry's hurdles and potential. The case studies are summarised in the Table 4.0.1.

Table 4.0.1: Key Case Studies and Subject Matter Experts in Malaysia's Electronics Sector

Case Study	Topic	Subject Matter Expert (SME)
Case Study 1	Gallium Nitride (GaN) Technology Adoption in Malaysia's Electronics Sector	Sivarama Rukumangatha RAJAH
Case Study 2	Advancements in Future Computing Technologies: AI and Quantum Computing	SOO Swee Yee
Case Study 3	Smart Manufacturing: Enhancing Efficiency and Innovation in Malaysia	Sivarama Rukumangatha RAJAH
Case Study 4	Challenges in Malaysia's Talent Development for the Electronics Industry	Huzein FAHMI
Case Study 5	The Talent Gap: Addressing the Limited Supply of E&E and Mechanical Engineering Graduates	Azwati AZMIN
Case Study 6	Declining Interest in Engineering Among Malaysia's Youth	TAN Kim Seah
Case Study 7	The Impact of Brain Drain on Malaysia's Engineering Talent Pool	MUI Kai Yin
Case Study 8	Navigating Regulatory Hurdles in Malaysia's Electronics Sector	LEOW Cheah Wei
Case Study 9	Regulatory Delays and Their Impact on Supply Chains – The Experience of Beye	LEOW Cheah Wei
Case Study 10	Violations of RBA Standards in Malaysia's Electronics Industry	LEOW Cheah Wei
Case Study 11	When Home Feels Distant – A Malaysian Diaspora's Reflection	CHIN Hon Keong

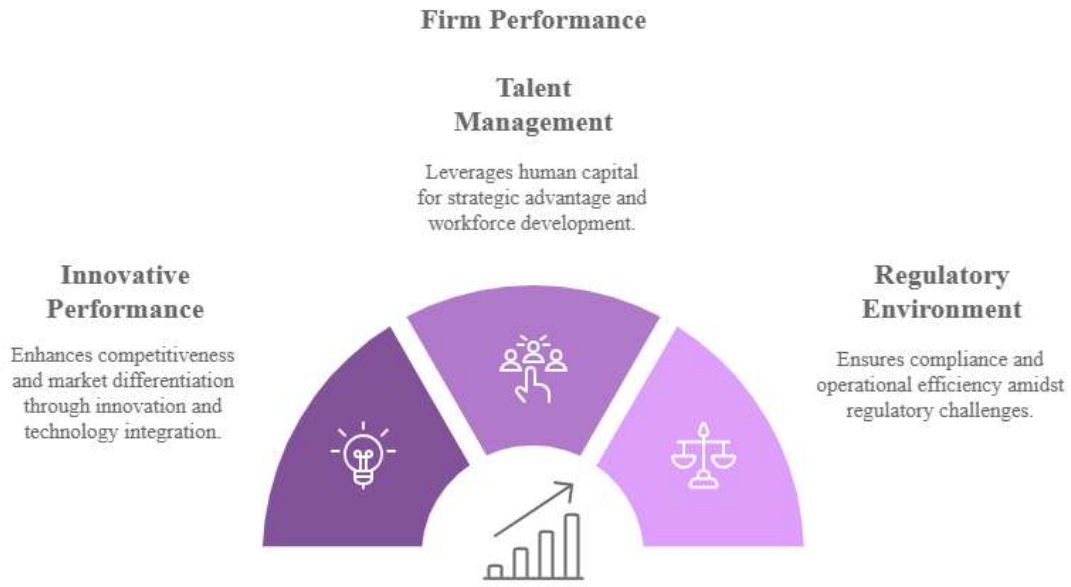


Figure 4.0.1 Key Strategic Drivers of Firm Performance: The Role of Innovation, Talent, and Regulation

Innovative Performance

Innovation performance, particularly the adoption of advanced technologies such as GaN semiconductors, artificial intelligence (AI), and quantum computing, is crucial for driving the industry's future growth. The following case studies illustrate Malaysia's experience with these frontier technologies and highlight opportunities to boost innovation:

- **Case 1 (GaN Technology Adoption):** Gallium Nitride is a next-generation semiconductor material promising superior performance in power electronics and RF applications. In Malaysia, the involvement of **CREST (Collabourative Research in Engineering, Science and Technology)** in a transcontinental GaN epitaxy program has given the country a foothold in GaN R&D. This case showed that by partnering with international program spanning the US and Malaysia (Crest, n.d.), Malaysian entities could leapfrog into cutting-edge tech domains. The result was increased interest from multinational companies to invest in compound semiconductor manufacturing locally. It underscores that targeted collabourative initiatives can attract foreign technology and know-how, partially mitigating the innovation investment gap discussed earlier. *Opportunity:* Expand such programs into other emerging areas (e.g., silicon photonics or 5G components) to position Malaysia at the forefront of new technology adoption.
- **Case 2 (AI and Quantum Computing Advances):** AI and quantum computing are transforming industries worldwide. In Malaysia, various initiatives (from academic research labs to startup incubators) are exploring these fields. **Soo Swee Yee**, a tech industry advisor, notes that Malaysia's AI sector has grown, evidenced by adoption of AI chatbots in customer service and the government's National AI Framework. However, quantum computing remains nascent. The case study discussion highlighted that while Malaysia is mostly a **user/adopter** of AI solutions (with AI market volume expected to reach a significant size as reported by Statista), it has an opportunity to contribute in niche areas like quantum algorithms or specialized AI applications for E&E manufacturing. Notably, Google's recent **Willow quantum chip** demonstration (performing in minutes what would take classical computers billions of years) served as a wake-up call: Malaysia must decide how to participate in this next frontier (perhaps

by focusing on quantum computing talent development or by providing incentives for global quantum tech firms to set up collaborations or facilities in Malaysia). *Opportunity:* Leverage existing strengths in electronics to venture into hardware for AI (like AI accelerator chips) or components for quantum devices, with government-backed R&D consortia to share costs.

- **Case 3 (Smart Manufacturing in Malaysia):** This case examined a local electronics firm's journey in adopting **Industry 4.0** practices – integrating IoT sensors, robotics, and data analytics into its production line. Guided by expert Sivarama R. Rajah, the firm managed to significantly increase efficiency and reduce defects. The government's incentives (like grants under the Industry4WRD policy) helped offset the initial investment. The case illustrates that Malaysian firms can innovate in **process technology** (not just products) by embracing automation and smart systems. This in turn enhances their competitiveness and frees up human capital for higher-order tasks (like design and R&D). *Opportunity:* Broader dissemination of such best practices through industry forums and government support could upgrade the overall manufacturing base. Encouragingly, fully automated "lights-out" manufacturing facilities, such as an automated wafer fabrication plant in Penang, are emerging as benchmarks for others.

Together, these cases on innovative performance demonstrate the importance of strategic partnerships, readiness to adopt new tech, and internal process innovation. They also reveal that when provided with the right support, Malaysian firms and institutions can indeed participate in high-tech innovation rather than lag behind. The opportunities lie in scaling these successes and systematically addressing the industries' weaknesses.

Talent Management

Talent management poses a substantial challenge, marked by a talent gap in E&E and Mechanical Engineering, declining youth interest in engineering, and a persistent brain drain, all of which threaten the sector's progress. Addressing these challenges is crucial for building a skilled workforce that can support and sustain the industry's growth. The following case studies delve into different aspects of Malaysia's talent issues in the electronics sector, echoing many problems from the problem statement but also indicating paths forward:

- **Case 4 (Talent Development Challenges):** The case study pointed out that while Malaysia produces many graduates, the specific skill sets for the E&E sector are lacking. A TalentCorp program aimed at identifying "Critical Occupations" listed various electronics-related jobs as in shortage. The challenge, as the case revealed, is not simply producing more graduates, but ensuring *they have relevant skills* (Talent Corporation Malaysia, 2023). For instance, few universities offered courses on semiconductor fabrication or FPGA design as part of their core curriculum. A positive aspect noted was TalentCorp's **Industry-Academia Collaboration** initiative (as mentioned on their website) which tries to bring industry input into curriculum design. However, uptake by educational institutions has been slow. *Opportunity:* Strengthen these collaboration programs, perhaps by incentivizing universities (funding, equipment donations) and requiring industry internships for students so they graduate with practical experience.
- **Case 5 (The Talent Gap – Limited Graduates): Azwati Azmin**, an academic at a local university, provided data on enrollment and graduation trends in electrical engineering. The case study confirmed a decline in students pursuing E&E fields over the past 5–10 years. It also highlighted efforts by some universities to reverse this, such as introducing **dual-degree programs with foreign universities** to make the field more attractive, or offering **industry-sponsored scholarships** for E&E students (where

companies fund a student's education in return for a bond to work with them). One major gap identified was at the **technician level**. Malaysia has plenty of engineers with degrees, but a shortage of skilled technicians with diplomas/certifications for roles like PCB assembly specialists, precision machinists, etc. This is partly due to social biases preferring degrees over vocational training. *Opportunity:* The German and Swiss models of vocational training were cited; Malaysia could elevate its polytechnics and vocational institutes by working closely with industry to ensure those graduating have guaranteed job placements (this improves the image and uptake of vocational tracks). Additionally, publicizing success stories of careers in electronics (to change youth perceptions) is needed e.g., showcase young engineers leading exciting projects in aerospace electronics or entrepreneurs in IoT hardware startups.

- **Case 6 (Declining Interest in Engineering):** This case delved into why students shy away from engineering. It corroborated reports that despite various campaigns, interest remains lukewarm. Factors mentioned include: students find STEM subjects difficult early on and there is insufficient support to help them; some teachers themselves are not well-equipped to inspire students in these subjects; and alternative fields (like IT or finance) seem more glamorous or accessible. A telling anecdote was that a high school robotics competition winner still chose to study business because he felt engineering had "no future" in Malaysia – a perception issue. The Ministry has been trying things like the recent policy where matriculation colleges allocate a certain quota for STEM, and initiatives to spark interest (e.g., coding classes, maker labs in schools). *Opportunity:* Expand hands-on STEM learning at younger ages to build passion (the case pointed to a pilot program where secondary students partnered with a local tech company to solve real problems, which was very well received). Also, better career counseling in schools about the opportunities in engineering could help adjust misperceptions. Involving industry professionals in these counseling or outreach programs can provide role models.
- **Case 7 (Brain Drain Impact): Mui Kai Yin**, representing an industry association, shared data that many experienced Malaysian engineers are working abroad (including a significant number in Singapore's semiconductor firms). The case cited a statistic: an estimated 5.5% of Malaysia's tertiary-educated citizens live overseas, which is almost double the global average, and many are from key sectors like engineering. For companies in Malaysia, this translates to difficulties in hiring for senior positions; they often have to either promote internally faster (sometimes before an employee is ready) or hire expatriates. Both approaches have drawbacks: skill gaps or higher costs. However, the case also noted some **returnees** professionals who gained experience abroad and came back to Malaysia to start their own businesses or lead new ventures (sometimes attracted by lower costs of living or wanting to contribute at home). Government programs like the **Returning Expert Program (REP)** were mentioned; they offer tax incentives for Malaysians abroad to return. Uptake has been modest. *Opportunity:* Improve the incentives and also address quality-of-life issues that cause brain drain (for example, issues like public transport, quality of local R&D environment, etc., though outside this paper's direct scope, were mentioned as factors). Another opportunity is tapping the diaspora virtually – e.g., create a network of Malaysian engineers abroad who can mentor or collaborate on projects in Malaysia, thus turning brain drain into "brain circulation." The case suggests that some diaspora members are willing to contribute expertise if mechanisms exist (webinars, part-time professorships, consulting on projects back home).

Across these talent cases, a common thread is the need for a systemic approach: education reforms, industry collaboration, and making Malaysia a place where talent wants to stay or return to. The opportunities identified often involve scaling up programs that have shown promise or borrowing models from abroad. One major insight is that Malaysia has pockets of excellence that top students and good universities are available, but connecting them effectively to industry needs improvement. Also, it's clear that without addressing talent, other efforts (like innovation initiatives) won't have the necessary human capital to succeed.

Regulatory Environment

Navigating the regulatory landscape in Malaysia's electronics sector can be challenging, but it also presents opportunities for reform and improvement. The case studies below illustrate some regulatory hurdles and how they have been or could be addressed:

- **Case 8 (Navigating Regulatory Hurdles):** This case examined a medium-sized electronics firm trying to scale up production. The firm faced multiple regulatory hurdles: protracted approval times for factory expansion, difficulties in obtaining work visas for a few foreign specialists, and compliance with various local standards not fully harmonized with international ones. The experience was that dealing with these hurdles required significant time and often personal follow-ups at different agencies. However, the case also noted improvements: Malaysia's introduction of the **Electronic Manufacturing Services (e-Manufacturing)** license process streamlined some approvals by bundling them into one application through MIDA. The firm eventually navigated the system by hiring a dedicated regulatory affairs manager and leveraging government contacts, but this is not feasible for all SMEs. *Opportunity:* Continue enhancing single-window systems. The government's ongoing **MySI** (Malaysia Single Interface) initiative, analogous to Indonesia's OSS, is expected to integrate more licensing processes online – pushing this forward will significantly ease regulatory navigation for businesses. The case suggests instituting an "ombudsman" or helpdesk specifically for tech companies to escalate regulatory issues might help SMEs who lack influence.
- **Case 9 (Regulatory Delays and Supply Chains – The Beye Experience):** *Beye* is a pseudonym for an electronics component supplier that encountered a serious delay issue. As referenced earlier, Beye imported a new type of component that got stuck due to **SIRIM's standards** not recognizing it. This case study traced the fallout: production lines at client companies paused, and Beye incurred extra logistics costs. It took interventions at high levels (a ministry) to get a one-time waiver. The situation highlighted a lack of agility in regulatory bodies to update standards in tandem with technology. On the flip side, it sparked discussions between industry associations and SIRIM to create a faster-track mechanism for certifying internationally approved materials. *Opportunity:* Implement a "pre-approval" system for materials/components that have been certified by reputable foreign standards bodies (e.g., if it's EU CE certified or US FDA approved, allow provisional use in Malaysia pending local assessment). Additionally, strengthen industry representation in standards committees so that upcoming industry needs are known in advance by regulators.
- **Case 10 (Violations of RBA standards):** This case, provided by **Leow Cheah Wei** in his capacity as a labour rights observer, dealt with a scenario where a Malaysian electronics factory was accused of **labour violations** (excessive overtime and unsafe dormitory conditions for migrant workers), violating Responsible Business Alliance (RBA) standards. The incident gained international attention (similar to actual reports involving major firms), and the firm risked losing contracts with a multinational customer. Regulators in Malaysia stepped in: the Department of Labour investigated

and the company was given a compliance order. The case ended with the company rectifying issues at significant cost, but retaining the client. It underscored that global buyers are enforcing standards even if local laws are less strict. *Opportunity:* Rather than wait for crises, Malaysia could proactively integrate RBA or ESG elements into its own regulatory framework. For example, develop national guidelines on worker welfare in electronics factories, or require annual social compliance audits for companies above a certain size with government support to implement improvements. This would protect Malaysia's reputation and make local firms more competitive, as they can credibly demonstrate compliance. Furthermore, Malaysia can differentiate itself by aligning with international sustainability efforts like being an early adopter of carbon reporting for factories, or banning certain hazardous substances ahead of others. Government incentives could support companies in making these transitions (e.g., grants for CSR improvements or green factory upgrades).

The regulatory cases make it evident that while Malaysia has room to improve in easing business processes, it is also catching up on newer regulatory demands like ESG. The opportunities often involve policy or administrative changes that aren't necessarily expensive but require political will and coordination. Importantly, the cases show that when regulators and industry communicate as eventually happened post-crisis, solutions can be found. Institutionalizing that communication through formal public-private dialogues and feedback loops on regulations, is a key opportunity the government should pursue.

4.1 Case Study 1: Gallium Nitride (GaN) Technology Adoption in Malaysia's Electronics Sector

Introduction:
Gallium Nitride (GaN) technology represents a promising frontier in the field of semiconductors, offering significant advancements over traditional silicon-based technologies. GaN's unique properties, such as high electron mobility and a wide bandgap, make it suitable for applications across power electronics, optoelectronics, and RF devices. Its potential to drive higher efficiency and performance in these areas positions GaN as a transformative technology for various industries. As GaN research and development progress, its integration into various industries is expected to revolutionize technological landscapes globally, including in Malaysia.

The Challenges and Maturity:
Recently, a major development in GaN technology occurred with Infineon's introduction of the world's first 300 mm GaN power wafer (Infineon Technologies Austria, 2024). This breakthrough offers 2.3 times more chips per wafer compared to the traditional 200 mm wafers, enabling greater scalability, improved performance, and cost efficiency in the production of GaN devices. Infineon's ability to use existing 300 mm silicon production lines significantly reduces costs, which could accelerate the adoption of GaN technologies across several industries, including automotive, industrial, and consumer electronics. This advancement is particularly crucial for Malaysia, as it enhances the country's attractiveness to global semiconductor players, who may leverage its strategic location for GaN-based manufacturing and R&D activities.

Applications of Technology:
GaN's superior properties enable various high-performance applications:

- **Power Electronics**: GaN-based power transistors are widely used in fast-charging solutions for smartphones and electric vehicles (EVs). GaN transistors can handle higher voltages and switch faster than silicon transistors, leading to more efficient power conversion in chargers and power supplies.
- **Optoelectronics**: GaN's wide bandgap makes it ideal for light-emitting diodes (LEDs), particularly blue and green LEDs, which are central to displays, general lighting, and communication systems. The efficiency and durability of GaN LEDs have accelerated their adoption in energy-efficient lighting.
- **RF Devices**: GaN is crucial in RF amplifiers for telecommunications and radar systems. GaN's high electron mobility and power density allow Radio Frequency (RF) devices to operate at higher frequencies and power outputs, making them essential for 5G infrastructure and defense applications.

As in Figure 4.1.1, this diverse range of applications highlights the strategic importance of GaN technology for Malaysia, providing the country with opportunities to strengthen its position in high-tech industries.

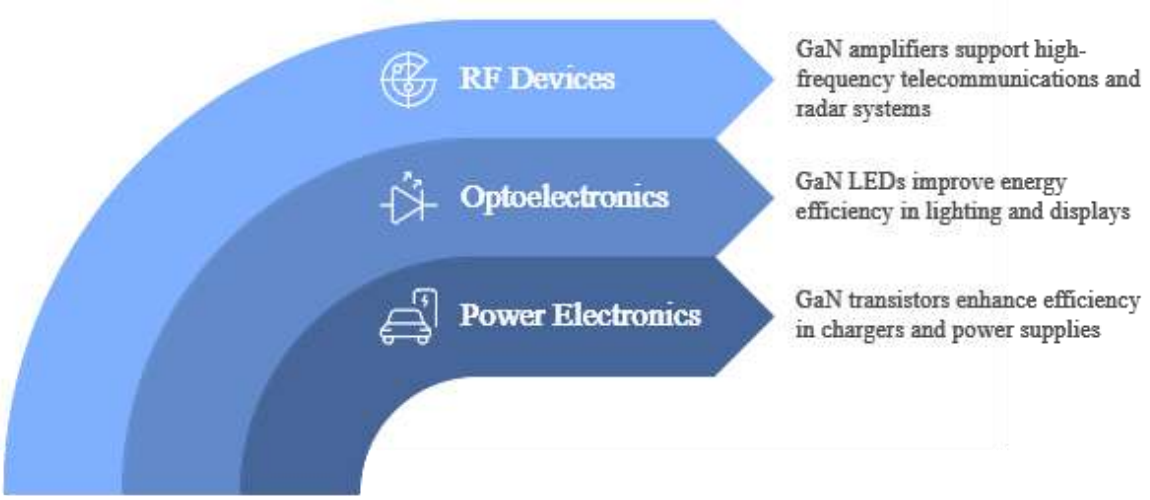


Figure 4.1.1: GaN technology application

Table 4.1.1: SWOT Analysis in Malaysia Context

SWOT Analysis		
Internal	**Strength**	**Weakness**
	• Government initiatives and collaborations with academic institutions and industry players have supported in building capabilities in GaN technology through CREST. These collaborations facilitate knowledge transfer, skill development, and access to cutting-edge GaN innovations.	• There is a limited indigenous GaN manufacturing. Malaysia currently relies on imported GaN materials and components, leading to dependency on foreign suppliers. The lack of indigenous GaN manufacturing facilities hampers the autonomy and may pose supply chain vulnerabilities.
	• Malaysia's semiconductor industries have established strategic partnerships with international companies specializing in GaN technology. Malaysia possesses a skilled workforce in engineering and technology sectors. These professionals contribute to GaN-related research, development, and implementation, driving innovation and competitiveness.	• Challenges such as inadequate logistics infrastructure could impede the widespread adoption of GaN technology, particularly in remote or underserved areas. Limited financial resources and infrastructure may hinder the scale-up of GaN research and development initiatives in Malaysia. Adequate funding and infrastructure are crucial for fostering a thriving GaN ecosystem.
	• Supportive regulatory environment conducive to technology adoption, fostering a landscape favourable for GaN integration across various sectors.	• Despite a skilled workforce, there may be a skills gap in specialized areas related to GaN technology.
External	**Opportunities**	**Threats**
	• GaN technology presents opportunities for Malaysia to diversify its industries, particularly in high-tech manufacturing, renewable energy, and telecommunications. By leveraging GaN's capabilities, Malaysia can enhance its competitiveness and expand the opportunities.	• Malaysia faces competition from other countries with established GaN industries, such as the Europe and Singapore. Without sufficient differentiation or competitive advantages, Malaysian firms may struggle to capture market share in the global GaN market.
	• As GaN technology matures, Malaysia can position itself as a hub for GaN-related manufacturing and	• The rapid pace of GaN innovation poses risks of intellectual property infringement or technology leakage.

	exports. By capitalizing on its strategic location, skilled workforce, and supportive policies, Malaysia can tap into global demand for GaN-enabled products and components.	Malaysian firms must prioritize intellectual property protection strategies to safeguard their innovations and remain competitive in the global market. Changes in regulations or trade policies, both domestically and internationally, can affect the import/export of GaN materials and components. Regulatory uncertainties or trade barriers may hinder the smooth flow of GaN-related activities and investments in Malaysia.
	• With supportive government policies and increasing awareness of GaN's benefits, Malaysia has an opportunity to accelerate the adoption of GaN technology across various sectors. Early adopters stand to gain a competitive edge and drive economic growth. GaN's superior power efficiency makes it well-suited for applications in renewable energy systems, electric vehicles, and power electronics.	• Market Volatility such as fluctuations in global demand, supply chain disruptions, or geopolitical tensions can impact the adoption and growth of GaN technology in Malaysia. Economic uncertainties or unforeseen events may disrupt investment plans and hinder GaN-related initiatives.

Key Challenges and Impact on the Firm Performance:
The adoption of Gallium Nitride (GaN) technology in Malaysia's electronics sector can significantly affect firm performance in several ways. Companies that successfully integrate GaN into their operations can achieve notable improvements in power efficiency and performance across multiple applications, from renewable energy systems to telecommunications. This technological edge can enhance product offerings and provide a competitive advantage in global markets.

Firms that capitalize on Malaysia's strategic location and government support for GaN research and development will be well-positioned to tap into global demand for GaN-related manufacturing and exports, increasing their revenue streams. However, firms that fail to adopt GaN technology or lack the necessary infrastructure and skilled talent may face operational inefficiencies, higher costs, and lost market opportunities.

To mitigate these risks, companies must invest in workforce training, infrastructure, and intellectual property safeguards to fully harness GaN technology's potential. In the long run, firms' ability to adapt to technological advancements in GaN will directly influence their market share, cost-efficiency, and financial performance, underscoring the importance of strategic investments in this area.

4.2 Case Study 2: Advancements in Future Computing Technologies: AI and Quantum Computing

Introduction:
Artificial intelligence (AI) and quantum computing are two rapidly advancing technologies poised to revolutionise various industries and sectors. Here's an overview of how each component is expected to shape the computing landscape:

- AI continues to advance and integrate deeper into various sectors from healthcare to finance. The growth and influence of AI system can be easily observed with more adoption of chatbots on various industries. The future will likely see AI becoming more autonomous and capable of performing complex tasks with minimal human intervention. AI systems will be designed to learn and adapt in real-time, making decisions based on vast amounts of data processed at incredible speeds.
- Quantum computing, on the other hand, promise the hardware revolutionary approach to redefine the boundaries of data processing power of classical computers. Quantum computers will be particularly transformative in fields like banking and finance, material science, cryptography, drug discovery, vehicle autonomy, and much more, where they can model complex molecular structures or crack codes that would take traditional computers millennia to decipher. Google's recently developed Willow quantum chip is claimed to perform a standard benchmark computation in under five minutes that a task that would take one of today's fastest supercomputers an estimated 10 septillion years (10^{25} years) (Neven, 2024).
- The integration of AI with quantum computing is expected to create synergies that amplify the capabilities of each technology. AI can optimize the performance of quantum computers and help in designing algorithms that harness their power. Conversely, quantum computing could accelerate AI's data processing and analysis capabilities, leading to breakthroughs in machine learning and AI-driven research. These benefits enable organizations to tackle even more complex problems and uncover new opportunities for growth and innovation.

The Challenges and Maturity in Global Market Forecasts and Statistics:

1. **AI market size is expected to reach USD 826.7 billion by 2030**
   The global AI market is projected to reach USD 184.0 billion in 2024 and expected to show an annual growth rate (CAGR 2024–2030) of 28.46%, resulting in a market volume of USD 826.7 billion by 2030 (Statista, 2024).

2. **64% of businesses expect AI to increase productivity**
   A significant 64% of businesses believe that artificial intelligence will help increase their overall productivity, especially on areas including cybersecurity, fraud management, content production and customer support, as revealed in a Forbes Advisor survey (Haan, 2023). This shows the significant AI's potential in transforming business operations.

3. **Quantum computing market size is expected to reach USD 12.6 billion by 2032**
   The global quantum computing market size was valued at USD 885.4 million in 2023 and is projected to grow from USD 1,160.1 million in 2024 to USD 12,620.7 million by 2032, exhibiting a CAGR of 34.8% during the forecast period (Fortune Business Insights, 2024).

Application and Technology – Malaysia Data Center Market and Increased Demand for AI:

Aligning with global semiconductor industry giants including Nvidia, Microsoft and Google had announced significant billions of dollars of investment for data centers and AI infrastructure. Nvidia and YTL power partner for USD 4.3 billion AI data centers (Latiff & Potkin, 2023), Google to invest USD 2.0 billion (Chiang, 2024), while Microsoft announces USD2.2 billion of investments (Associated Press, 2024). With the significant expansion of data centers facilities, these are evidence that Malaysia has strong demands in the field of AI, considering AI supports to optimize data center network for GPU efficiency, reliability and performance.

On the other hand, the Artificial Intelligence Roadmap 2021–2025 published by MOSTI reflects the proactiveness from the government to adopt AI technology as well as to create a thriving and sustainable AI innovation ecosystem (Ministry of Science, Technology and Innovation, 2023). This will be a strong catalyst to local AI consulting services and solutions industry that help businesses integrate AI for their processes and operations optimization, and scale it across the organization to maximize the value.

With businesses more reliant on AI and connected data, the underlying Cybersecurity risks must not be forgotten. Malaysia Cyber Security Strategy 2020–2024 reveals that the management of cyber security risks should evolve simultaneously with the evolution of threats, alongside the adoption of digital in doing business (Chew & Kan, 2024). Officially gazetted on June 26, 2024, the Cyber Security Act 2024 makes a comprehensive legal framework to fortify the nations' digital defences (Medina, 2024).

Key Challenges and Impact on the Firm Performance:

1. **Lack of skilled professionals**

   According to the Human Resources Development Fund (HRDF), there should be at least 20,000 data professionals and 2,000 data scientists by 2020 (Lim, 2018; HRDF, 2020). There are, however, just over 14,000 data professionals in Malaysia to date. The country also requires 12,000 experts on big data, which concerns data sets too large or complex to be dealt with by traditional data-processing software (FMT, 2021).

   On the other hand, as of November 2023, there were only 13,000 Cybersecurity specialists in the market, while Malaysia needs at least 25,000 Cybersecurity specialists by 2025 (Malay Mail, 2023).

   A significant talent gap exists, despite the high demand for skilled individuals in local market. This is the reason Malaysia has resorted to hiring oversea professionals.

2. **Cost consideration**

   Cost is the most notable challenge for business to adopt AI services and solutions. The cost of building a custom AI project in an organization can vary widely depending on various factors, including:

   - development costs to design and build the needy AI system;
   - data-related costs for acquiring, cleaning, and managing data;
   - infrastructure costs for setting up and maintenance of hardware and software of the infrastructure;
   - operational costs including electricity, cooling and computing resources; and
   - human resource cost, such as hiring of AI professionals

The financial implications of AI adoption of a business are crucial for any organization planning to harness the capabilities. High initial cost in AI technologies could be a setback to certain businesses if the benefit-cost ratio remains low.

3. **Lack of national strategy for quantum technologies**
   According to Kung and Fancy (2021) by the Canadian Institute for Advanced Research (CIFAR), as of 2022, at least 46 countries have already undertaken a more or less systematic approach to funding QT adoption. Unfortunately, Malaysia is not represented on this map (see Figure 4.2.1).

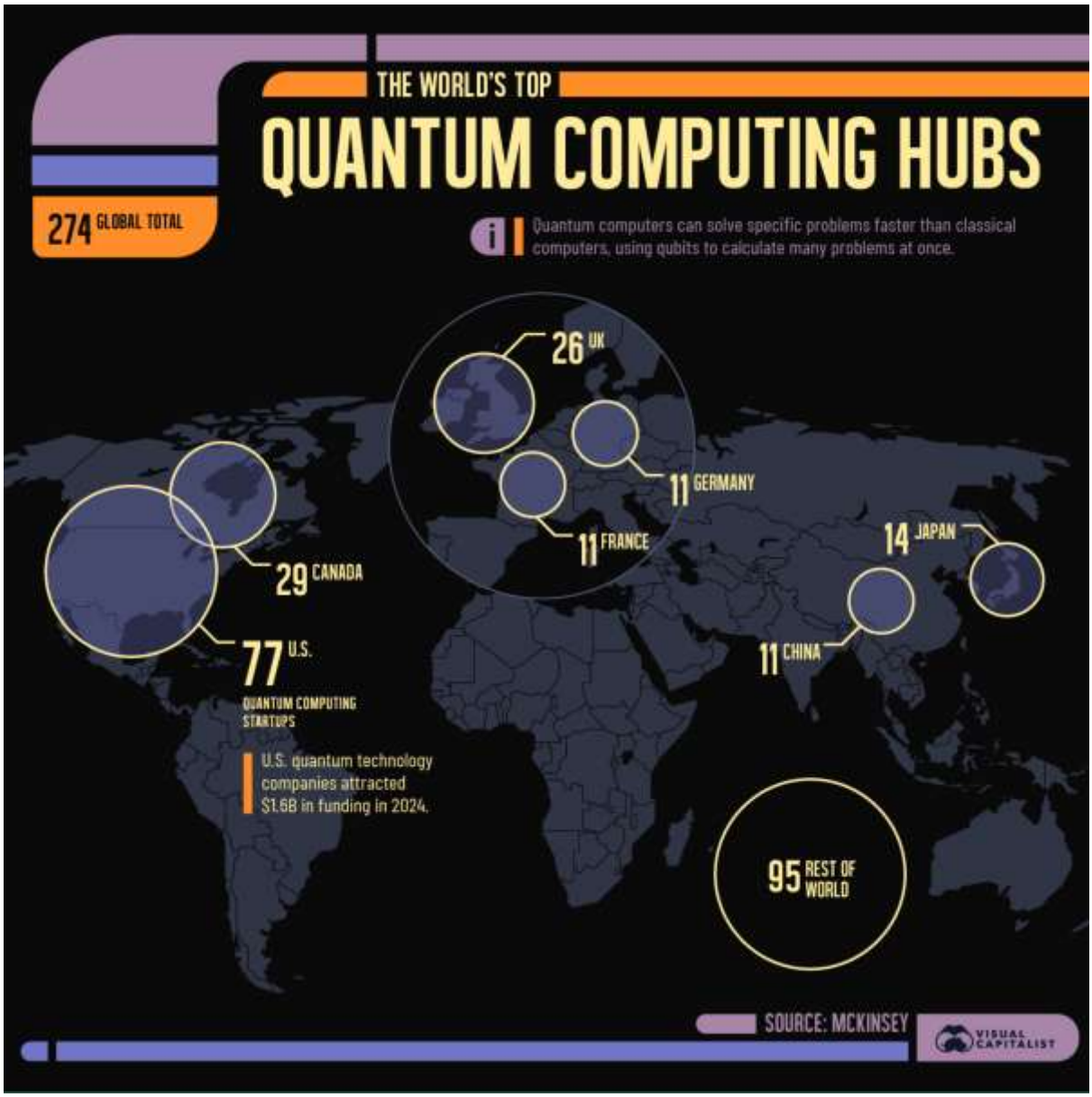


Figure 4.2.1 The World's Top Quantum Computing Hubs (McKinsey & Company, 2025)

Table 4.2.1 provides the voids in comparison to regional counterparts. There's a noticeable absence of any homegrown quantum-focused startups from Malaysia. In terms of the government support, it is significant that Malaysian QT field lacks government funding comparing to neighbour countries including Singapore and Thailand. Regardless, research

groups in Malaysia are started to form in universities who seen the great need and potential in QT. It is crucial for the Government to identify Malaysia positioning in the topic that can benefits the business ecosystem within the country.

Table 4.2.1: Overview of National Quantum Technology Ecosystem in the Region

Country	INPUTS - OUTPUTS				OUTCOMES - IMPACTS		
	Explicit National Quantum Strategy / roadmap	Gov. funding in QT as of Jan 2023, $US	# of universities with advanced quantum physics programs, QT research groups/ labs/ centers of excellence	# of gov. and non-profit agencies that perform research or provide funding for QT	# of local quantum-focussed private/start-up companies	# of local public companies investing in QT research and developing practical applications	# of patent applications in the WIPO database by applicant address country for Int. Class: G06N10/00
Australia	National Quantum Roadmap (2017), National Quantum Strategy (2023)	$98.5 million	10	2	11	1	2019: 2, 2020: 5, 2021: 5, 2022: 4, 2023: 1 **Total = 17**
China	China's Innovation Strategy, Made in China 2025 strategy	$25 billion	6	2	14	6	2019: 1, 2020: 7, 2021: 18, 2022: 48, 2023: 31, 2024: 1 **Total = 106**
India	National Mission on Quantum Technology & Applications	$1.1 billion	7	2	15	1	2022: 5 **Total = 5**
Indonesia	—	—	—	—	—	—	—
Hong Kong	—	—	—	—	3	—	—
Japan	Vision of Quantum Future Society (2022), Strategy of Quantum Future Industry Development (2023)	$1.8 billion	7	1	18	6	2019: 3, 2020: 10, 2021: 21, 2022: 23, 2023: 24 **Total = 81**
Malaysia	—	—	2	1	—	—	—
New Zealand	—	$36.7 million	4	1	1	—	—
Philippines	—	—	—	—	—	—	—
Singapore	—	$121.6 million	1	2	6	—	2021: 2, 2022: 3, 2023: 1 **Total = 6**
South Korea	National Strategic Plan for Quantum Science and Technology (2021), Quantum Science and Technology Strategy (2023)	$52 million	3	1	9	3	2019: 1, 2020: 1, 2021: 1, 2022: 4, 2023: 5 **Total = 12**
Taiwan	—	$282 million	4	—	9	1	—
Thailand	—	$6 million	1	1	1	—	—
Vietnam	—	—	—	—	—	—	—

Sources:
- https://quantumcomputingreport.com by Global Quantum Intelligence, a quantum research and consulting firm tracking government-funded projects by agencies and institutes worldwide
- PATENTSCOPE by World Intellectual Property Organization
- EMIR Research's own compilations are based on publicly reported information.

Impact to the Firm Performance:
The integration of AI and quantum computing into various industries, especially in Malaysia, holds profound implications for firm performance. Companies that effectively adopt these technologies stand to gain substantial advantages in terms of operational efficiency, decision-making speed, and overall productivity. AI can optimize business processes, from customer service to supply chain management, while quantum computing offers the potential to solve highly complex problems that are beyond the reach of classical computers. These advancements can lead to cost reductions, improved product quality, and faster time-to-market for innovative solutions.

However, businesses that are slow to integrate AI and quantum computing technologies could face competitive disadvantages, as they may struggle to keep up with the rapid technological advancements driving their industries. Additionally, the high cost of adopting AI and quantum computing solutions, along with the scarcity of skilled professionals, poses significant barriers for smaller firms and may delay their ability to fully leverage these technologies. For firms to thrive in this evolving landscape, they must invest in the necessary infrastructure and talent, while also benefiting from government support and collabourative initiatives that drive innovation in future computing technologies.

With the huge potential of quantum technologies in revolutionize computation, the international race for the superiority in the field is heating up. Malaysia government, however, is lacking proactive strategies and measures to benefit Malaysia with early technology adoption.

4.3 Case Study 3: Smart Manufacturing: Enhancing Efficiency and Innovation in Malaysia

Introduction:
Manufacturing is the process of producing effective products using machinery, labour, tools, and well-formulated theory. During the manufacturing process, industries experience various kinds of provocations, including unexpected failures of equipment and machines, downtime failures and products delivered in an imperfect way (Maheswari & Brintha, 2021). Hassan, Al-Kindi & Abdulghafour (2023) highlighted that Smart Manufacturing enables the deployment of big data processing, artificial intelligence, and robotics technologies. These interconnected tools improve manufacturing performance while optimizing energy and labour needs.

The Challenges and Maturity:
Lately, Malaysia has been actively pursuing smart manufacturing initiatives, particularly in the semiconductor industry, to enable advancements in power management and future computing areas such as artificial intelligence (AI). These initiatives included:

- **Integration of Advanced Technologies:** Smart manufacturing initiatives in Malaysia involve the integration of advanced technologies such as 3D packaging, AI, machine learning, and data analytics to optimize power management and enhance computing capabilities. These technologies enable predictive maintenance, real-time monitoring, and optimization of power usage in semiconductor manufacturing processes. This includes the development of AI-enabled semiconductor solutions. Malaysia's semiconductor industry is actively involved in the development of AI-enabled semiconductor solutions to support future computing applications. This includes the design and manufacturing of AI chips, processors, and specialized hardware accelerators optimized for AI workloads.
- **AI-driven Predictive Maintenance:** AI-powered predictive maintenance techniques are being adopted in semiconductor manufacturing facilities in Malaysia to monitor equipment health and performance in real-time. By analysing data from sensors and other sources, AI algorithms can predict equipment failures before they occur, reducing downtime and optimizing maintenance schedules. This energy-efficient and smart manufacturing in Malaysia focuses on improving energy efficiency in semiconductor manufacturing processes. This includes the deployment of advanced power management systems, energy monitoring tools, and optimization algorithms to minimize energy consumption and reduce environmental impact.
- **Energy-efficient Manufacturing:** Smart manufacturing practices in Malaysia focus on improving energy efficiency in semiconductor manufacturing processes. This includes the deployment of advanced power management systems, energy monitoring tools, and optimization algorithms to minimize energy consumption and reduce environmental impact.
- **Development of AI-enabled Semiconductor Solutions:** Malaysia's semiconductor industry is actively involved in the development of AI-enabled semiconductor solutions to support future computing applications. This includes the design and manufacturing of AI chips, processors, and specialized hardware accelerators optimized for AI workloads.
- **Collaboration and Knowledge Exchange:** Collaboration between industry players, research institutions, and government agencies is driving innovation in smart manufacturing for power management and future computing in Malaysia. Initiatives such as research grants, technology transfer programs, and industry-academia partnerships facilitate knowledge exchange and technology development. Malaysia's

commitment and investment on research and development (R&D) in the semiconductor sector is fuelling advancements in smart manufacturing technologies. R&D initiatives through leadership by various research institutions focus on developing next-generation semiconductor materials, devices, and manufacturing processes to support AI and future computing applications. Malaysia is investing in high skilled workforce development programs like Technical and Vocational Education and Training (TVET) to ensure a skilled talent pool capable of driving innovation in smart manufacturing for power management and future computing. Training programs, workshops, and collaborations with educational institutions equip workers with the necessary skills in AI, data analytics, and semiconductor manufacturing.

- **Investment in Research and Development:** Malaysia's commitment to expedite the R&D in the semiconductor sector is fuelling advancements in smart manufacturing technologies. R&D initiatives through leadership by various research institutions focus on developing next-generation semiconductor materials, devices, and manufacturing processes to support AI and future computing applications.
- **Workforce Development:** Malaysia is investing in workforce development programs like TVET to ensure a skilled talent pool capable of driving innovation in smart manufacturing for power management and future computing. Training programs, workshops, and collaborations with educational institutions equip workers with the necessary skills in AI, data analytics, and semiconductor manufacturing.

Smart manufacturing initiatives in Malaysia are playing a crucial role in enabling advancements in power management and future computing, particularly in the semiconductor industry. By leveraging advanced technologies, fostering collaboration, and investing in workforce development, Malaysia is positioning itself as a key player in the global semiconductor landscape for AI and future computing applications.

Table 4.3.1: SWOT Discussion

SWOT Analysis		
Internal	Strength	Weakness
	• Government Support: Strong backing from government policies and incentives drives innovation and adoption of smart manufacturing practices. Extensive collaboration between government, industry, academia, and research institutions fosters innovation and knowledge exchange in smart manufacturing initiatives.	• Limited Adoption Rate: Despite government support, the overall adoption of smart manufacturing technologies remains relatively low among Malaysian industries. There are still some fundamental infrastructure challenges such as facilities stability, inadequate digital infrastructure, and cybersecurity concerns pose challenges to seamless integration of smart manufacturing technologies.
	• Established Industrial Ecosystem: Robust infrastructure and available skilled workforce provide a solid foundation for implementing advanced manufacturing technologies.	• Fragmented Ecosystem: Lack of coordination and collaboration among stakeholders results in a fragmented smart manufacturing ecosystem, inhibiting innovation and knowledge sharing. Upfront investment costs for implementing smart manufacturing solutions can be prohibitive, particularly for SMEs, limiting widespread adoption.
	• Strategic Location: Malaysia's position in Southeast Asia facilitates access to regional markets and global supply chains, enhancing competitiveness. A well-developed & >50 years of semiconductor sector serves as a catalyst for smart manufacturing advancements, leveraging expertise and resources for a strong semiconductor industry supply chain.	• Skills Gap: There is a shortage of high skilled and latest technology competence workers proficient in emerging technologies such as data analytics, artificial intelligence, and automation, hindering effective implementation.
External	Opportunities	Threats
	• Export Growth: Leveraging smart manufacturing capabilities to produce high-quality semiconductor	• Global Competition: Intense geo-political tension & local region competition with advanced manufacturing

	end products for export markets, driving economic growth and competitiveness. Collabourating with international partners and stakeholders to develop new markets, technologies, and best practices, fostering growth and competitiveness in embracing smart manufacturing.	capabilities poses a threat to Malaysia's position in the smart manufacturing landscape. Economic volatility and market uncertainties could impact investment decisions and slow down the adoption of smart manufacturing technologies
	• Industry 4.0 (IR 4.0) Adoption: Embracing Industry 4.0 technologies to enhance productivity, efficiency, and innovation across manufacturing sectors. Opportunity in digital transformation by seizing opportunities for digital transformation by integrating smart technologies to optimize processes, reduce costs, and improve decision-making.	• Supply Chain Disruptions: Disruptions in global supply chains, whether due to natural disasters, geopolitical tensions, or pandemics, could disrupt production and hinder smart manufacturing operations. Evolving regulations and compliance requirements may pose challenges and increase operational costs for smart manufacturing initiatives.
	• Talent Development: Investing in tertiary syllabus, training programs and education initiatives to address the skills gap and cultivate a highly skilled workforce for smart manufacturing.	• Talent Readiness Risks: Increased connectivity and digitization expose smart manufacturing systems to talent readiness threats such as competency and technology sustainability, as well as hiring by other countries.

Table 4.3.2: PESTLE Discussion:

Category	Factors
Political	**Political Stability:** Supportive government policies drive innovation. Political stability encourages foreign investment. Trade agreements facilitate global market access.
Economic	**Economic Growth:** Growing GDP fuels industry expansion. Stable currency promotes investment. Access to skilled labour enhances productivity.
Social	**Environmental Regulations:** Stringent environmental laws promote sustainability. Renewable energy incentives drive green initiatives. Eco-friendly practices enhance corporate reputation.
Technological	**Technological Advancements:** Embrace of Industry 4.0 drives automation and innovation. Access to skilled workforce fosters technology development. Collaboration with global tech partners enhances competitiveness.
Legal	**Compliance Requirements:** Adherence to labour laws and safety regulations is essential. Intellectual Property Protection: Stringent IP laws safeguard innovation and technology investments. Industry-specific Regulations: Adapting to sector-specific regulations ensures legal compliance and competitiveness.

Application and Technology:

Based on the comprehensive analysis of smart manufacturing in Malaysia, several key recommendations can be made to further strengthen the industry. Firstly, Malaysia should prioritize investment in skills development to address the existing skills gap in emerging technologies such as advanced 3D packaging, data analytics, artificial intelligence, and automation. This can be achieved through collaborative efforts between industry stakeholders and educational institutions to design specialized education syllabus, training programs and courses tailored to the needs of the smart manufacturing sector. Additionally, enhancing government support with targeted incentives, grants, and streamlined regulations will encourage more companies to adopt smart manufacturing technologies, driving innovation and competitiveness. Promoting industry collaboration and knowledge-sharing platforms will facilitate the exchange of best practices, fostering a culture of innovation and continuous improvement across the sector. Moreover, a strong focus on sustainability and environmental compliance is essential to ensure the long-term viability and reputation of smart manufacturing operations in Malaysia.

By embracing digital transformation, adapting to market trends, and fostering a culture of innovation, Malaysia can further solidify its position as a leading hub for smart manufacturing in the region, driving economic growth and prosperity. Malaysia is on the path of IR4.0. With a small population, it needs to drive up productivity and depend less on low-cost foreign labour. To achieve these development objectives, technology implementation is the way forward (International Trade Administration, 2023).

Key Challenges and Impact on the Firm Performance:
The adoption of smart manufacturing technologies in Malaysia holds significant implications for firm performance, particularly in the E&E sector. Firms that embrace advanced technologies such as AI-driven predictive maintenance, energy-efficient manufacturing, and the integration of automation will likely experience enhanced operational efficiency, reduced downtime, and optimized resource allocation. These improvements boost productivity and profitability. Furthermore, the ability to maintain competitive energy management and introduce innovative products in a rapidly evolving global market will be a critical factor in sustaining long-term competitiveness.

However, companies that are slow to adopt these technologies may face increased operational costs, supply chain vulnerabilities, and challenges in maintaining quality and output, which could erode their market share. SMEs, in particular, may struggle to keep pace due to higher initial costs and a skills gap, thereby impacting their ability to compete both domestically and globally. As Malaysia continues to push for Industry 4.0 integration, firms that actively engage in digital transformation and workforce development will find themselves better positioned to capitalize on the opportunities, thus driving overall firm performance and industry growth.

4.4 Case Study 4: Challenges in Malaysia's Talent Development for the Electronics Industry

Introduction:
The E&E industry serves as a vital pillar of the Malaysian economy, playing a significant role in driving economic growth and development. With its roots tracing back to the early 1970s, this sector has flourished into a cornerstone of Malaysia's industrial landscape. According to The Star publication titled *E&E: 50 Years in Malaysia*, as shown in Figure 4.4.1, the industry's robust presence is evident in its substantial contribution to the economy, with E&E exports rising significantly from RM 288 billion in 2016 to RM 456 billion in 2021 (The Star, 2022).

According to the BERNAMA (2022), the E&E industry contributed 6.85% to Malaysia's Gross Domestic Product (GDP) in 2021. With the Malaysian government setting ambitious targets of RM120 billion in GDP growth and RM 495 billion in export earnings by 2025, this sector is poised to serve as a key catalyst for the country's economic progress.

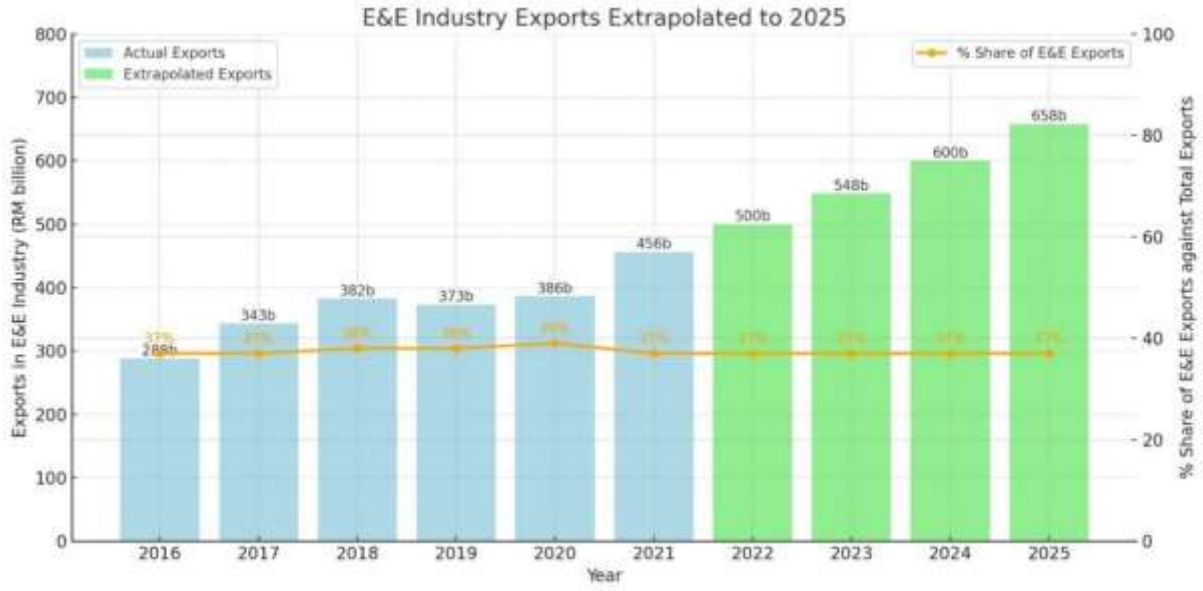


Figure 4.4.1: Malaysia E&E Exports Trend from 2016 to 2021 (The Star, 2022)

NIMP 2030 – Strategic Blueprint for Malaysia's Manufacturing and E&E Sector Growth:
On September 1, 2023, Prime Minister Dato' Seri Anwar Ibrahim launched the New Industrial Master Plan (NIMP) 2030. This strategic framework sets a clear direction for Malaysia to enhance its manufacturing sector and related services over the next seven years, with a focus on sustaining global competitiveness and driving economic growth (HSBC, 2023). The New NIMP plays a pivotal role in catalysing the growth of the E&E industry by outlining strategic priorities, fostering innovation, and enhancing the ecosystem to support the sector's development, thereby driving economic progress and competitiveness in Malaysia. (Ministry of International Trade and Industry, 2023)

Talent Shortages in Malaysia's E&E Industry – Addressing Supply-Demand Gaps:
Despite the prosperity and strategic planning, the E&E industry faces a critical challenge of talent and technical skill shortages. Ipsos Business Consulting (2012) report related to the E&E

Sector Study specifically on the Malaysia Supply-Demand of Talent, it is found that there is a shortage of E&E Engineers in Malaysia. The analysis of this study indicates that new addressable supply is not able to meet the incremental talent demanded by the E&E sector for its core technical talent. As in Figure 4.4.2, there is a significant gap in the talent supply-demand projections from 2012 to 2014. While the potential talent pool is twice the amount of the projected incremental demand, the addressable talent pool will only be able to meet about 57% of projected incremental demand. According to Talent Corporation Malaysia (2017), given the talent shortage, careers in the E&E industry have also been recognized as critical occupations in Malaysia.

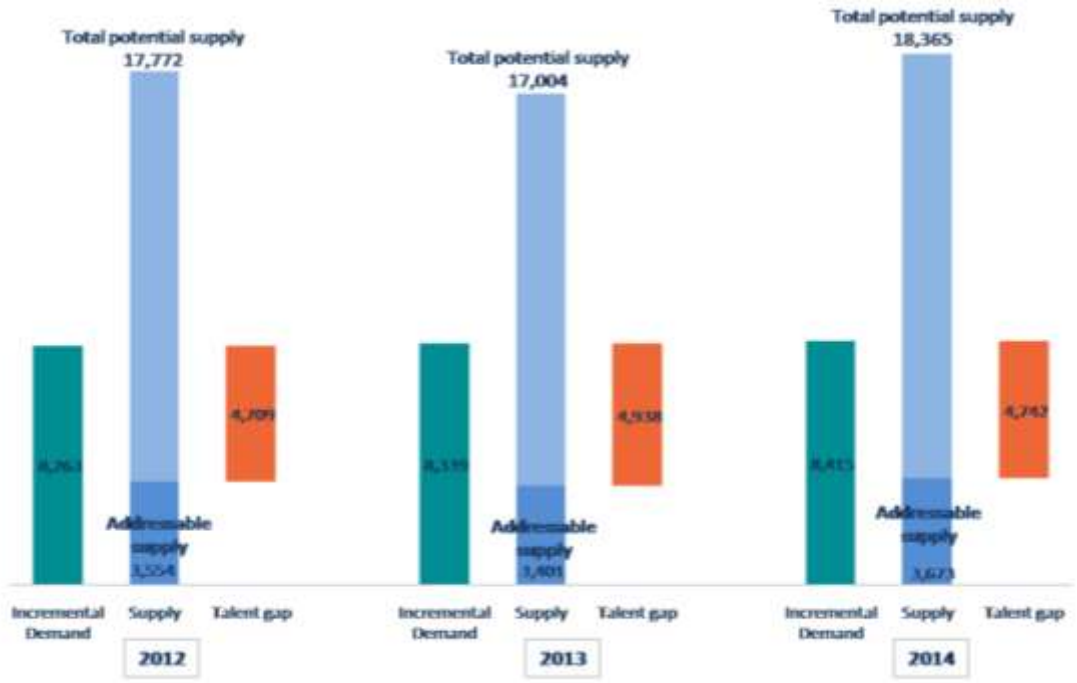


Figure 4.4.2: Supply vs Talent Demand in E&E Sector from 2012-2014 (Ipsos Business Consulting, 2012)

The IPSOS report also highlight the sector also faces talent shortage areas study also identified several areas where the talent shortage is prevalent and the areas in demand for E&E fresh graduates in the area as follows:

- IC Design Engineer
- Embedded System/Firmware Engineer
- Software Engineer
- Radio Frequency (RF) Engineers
- Product Design R&D Engineers

Engineer Shortage in Malaysia's Semiconductor Industry – Survey Findings and Impact: In 2022, the Malaysia Semiconductor Industry Association (MSIA) also conducted a comprehensive survey encompassing 93 MSIA members across various sectors, including semiconductors and electronics, spanning from manufacturing to services. It was conducted from February to June 2022, followed by a refresher survey in December 2022. The findings of this survey were striking, revealing that a significant 65% of talent shortages were attributed

to engineers (Malaysia Semiconductor Industry Association, 2022). In response to the survey, MSIA president Datuk Seri Wong Siew Hai pointed out that the talent shortage meant that the majority of respondents in the survey are still struggling to attract new talent (specifically engineers) while more than half of the companies expect to suffer from high employee turnover rates of above 10% (Houng, 2023).

Penang's Growing Demand for Engineering and IT Skills:
In Penang, often referred to as the Silicon Valley of the East, the Penang Talent Prospects 2023 survey designed by Penang Institute in collaboration with Penang Skills Development Centre (PSDC) and Penang STEM, highlighted significant skills and manpower shortages within the state's manufacturing industries. Out of the 73 organizations that participated in the poll, 39% are from the E&E sector. Industry participants predict that between 2023 and 2026, there will be a significant increase in demand for engineering and IT skills in both the manufacturing and associated industries, with an annual growth rate of 30% (Huong, 2023).

Recently, Investment, Trade and Industry Minister Datuk Seri Tengku Zafrul Abdul Aziz highlighted in a MITI Dialogue 2024 held on 29 January 2024, underlined again that the severe shortages of talent development in Malaysia. He elaborated that the E&E sector requires 50,000 engineers, but Malaysia, on the other hand, only produces 5,000 engineer graduates a year (Penang Institute, 2023).

This shortfall impedes the ability of industries, including the vital E&E sector, to fully capitalize on growth opportunities and meet their evolving workforce needs. As a result, it hampers Malaysia's overall economic competitiveness and innovation potential, hindering progress in key sectors that rely on engineering expertise. Thus, a detailed strategy is required to mitigate the impact of talent shortage in the E&E industry.



Figure 4.4.3: Top Impacts of Talent Shortages on Business Operations in Malaysia (Malaysia Semiconductor Industry Association, 2022)

Key Challenges and Impact to the Firm Performance:
The ongoing talent shortage in Malaysia's E&E industry significantly affects firm performance, leading to decreased business revenue and investment, missed opportunities for new projects and product wins, and delays in project delivery, R&D, and Industry 4.0 implementation, as shown in Figure 4.4.3 (Malaysia Semiconductor Industry Association, 2022). The limited supply of skilled engineers, particularly in critical areas such as IC design, embedded systems, and RF engineering, creates a significant bottleneck for firms striving to innovate and scale their operations. This shortage can lead to increased operational costs as companies compete to attract top talent, potentially raising salaries and recruitment expenses. Additionally, with many firms facing high turnover rates and difficulty retaining engineers, the stability and continuity of long-term projects may be compromised, delaying product development and reducing overall productivity.

Furthermore, this talent gap hinders firms' ability to adopt cutting-edge technologies such as smart manufacturing, Internet of Things (IoT), and 5G, which are crucial for remaining competitive in the global market. Without a robust pipeline of skilled graduates, Malaysian companies may struggle to meet the government's ambitious export and GDP growth targets for the E&E sector. This could ultimately impact their global competitiveness, market share, and ability to contribute to Malaysia's broader economic goals, particularly in the face of rapid technological advancements in the industry. Therefore, addressing the talent shortfall is not only essential for meeting immediate business needs but also critical for sustaining long-term growth and innovation in the sector.

4.5 Case Study 5: The Talent Gap: Addressing the Limited Supply of E&E and Mechanical Engineering Graduates

Introduction:
This case study discusses the critical talent gap in Malaysia's E&E and Mechanical Engineering sectors. The shortage STEM from rapid technological advancements, inadequate collaboration between academia and industry, and a lack of practical experience for graduates. Furthermore, declining student enrolment in STEM fields, particularly in E&E and Mechanical Engineering, intensifies the problem. The study highlights the implications of this skills gap for firm performance, including project delays, reduced innovation, and increased recruitment costs, and calls for urgent actions to address these challenges and ensure sustainable industry growth.

Key Factors Contributing to the Skills Gap in E&E and Mechanical Engineering:
There are several factors contribute to the skills gap in E&E and Mechanical Engineering:

- **Rapid Technological Advancement:** The E&E and Mechanical Engineering fields are characterized by rapid technological evolution. Curricula often struggle to keep pace with the latest industry trends, leading to graduates lacking proficiency in emerging technologies.
- **Industry-Academia Disconnect:** A lack of effective communication and collaboration between industry and academia can result in graduates with skills that are not aligned with industry needs.
- **Practical Experience Deficiency:** Many engineering programs focus heavily on theoretical knowledge, with limited emphasis on practical application and hands-on experience. This can hinder graduates' ability to adapt to real-world challenges.
- **Soft Skills Neglect:** While technical skills are crucial, soft skills such as communication, teamwork, problem-solving, and critical thinking are equally important for career success. A lack of emphasis on these skills can limit graduates' employability.

Decline in STEM Enrolment and Its Impact on Engineering Talent Supply:
One major concern is the overall decline in STEM intake among students. Similar to the global scenario, acquiring precise and consistent data on STEM enrolment in Malaysia can be challenging. Furthermore, Malaysia has struggled to meet the human capital need that will be required in STEM fields. Malaysia is not alone in having a low number of students studying STEM programmes; other countries are as well such as America, Denmark and others (Ong & Ling, 2020). Citing the Education Ministry's 2020 Annual Report, Science, Technology and Innovation Minister (MOSTI) Datuk Seri Dr Adham Baba said that the percentage of students in STEM was 47.18% with 20.51% involving Pure Science, while the remaining 26.67% was for TVET. MOSTI is concerned about the percentage of students in STEM because the STEM talent will be the catalyst for the development of a country.

This trend is problematic because it can lead to a shortage of skilled professionals in STEM related industries, which are crucial for the nation's technological and economic growth. In the year of 2019, only about 44% of students in schools chose STEM streams compared to 48% in 2012. This reduction is significant when considering the future needs of Malaysia's industries (Malay Mail, 2019; Supramaniam, 2023). While, according to STAR, the numbers of student enrolment in STEM education in schools rose to 45.73% as of August in 2023 (Gimino, Tan & Vethasalam, 2024). Education Minister Fadhlina Sidek said the increase was from 40.95% recorded in 2021 (BusinessToday, 2023).

Several factors contribute to this decline, including a lack of awareness about the career opportunities in STEM fields, misconceptions about the difficulty of STEM subjects, and inadequate resources and infrastructure in schools, especially in rural areas. Additionally, there is a shortage of qualified STEM teachers, further exacerbating the issue. Addressing these challenges is crucial for Malaysia's economic growth and technological advancement. Enhancing STEM education through improved resources, teacher training, and awareness campaigns can help reverse this trend and ensure a steady supply of engineering graduates to support industry demands.

These enrolment trends have significant implications for industries that rely on a steady supply of engineering graduates. Without sufficient graduates in fields like E&E and Mechanical Engineering, Malaysia may face challenges in maintaining and advancing its industrial capabilities. The limited supply of graduates in E&E, Mechanical, and other related engineering fields is a growing concern for the Malaysian industry. This issue is driven by several factors, including a declining trend in student enrolment in these programs. Recent data highlights that fewer students are opting for engineering courses, particularly in the wake of the COVID-19 pandemic. According to the trend data gathered from Universiti Teknologi MARA (UiTM) Penang Branch, data shows that only 135 students enrol in Engineering Course out of total 530 student's enrolments in 2022 as shown in Figure 4.5.1.



Figure 4.5.1: Data shows the enrolment numbers of student in Universiti Teknologi MARA (UiTM) Penang Branch (Sistem Kajian Pengesanan Graduan, UiTM Penang Branch retrieved on 26 June 2024).

Educational and Economic Factors Behind the Engineering Talent Shortage:
The modern industrial landscape is heavily reliant on skilled professionals in various engineering disciplines, particularly E&E and Mechanical Engineering. However, there is an increasing concern regarding the limited supply of graduates in these crucial fields, which poses significant challenges to the growth and sustainability of the industry. Several factors contribute to this shortage:

A. Educational Pipeline Issues:

- **Enrolment Rates**: There is a declining trend in the number of students enrolling in E&E, Mechanical, and other related engineering programs since 2012. This can be attributed to a variety of reasons including the perceived difficulty of these programs, lack of awareness about career prospects, and competition from other fields like information technology and business.
- **Curriculum and Resources**: Many educational institutions may lack the updated curriculum, modern labouratories, and sufficient resources to attract and retain students in engineering programs. This can lead to a mismatch between the skills taught in universities and the needs of the industry.

B. Economic Factors:

- **Competitive Salaries and Benefits**: Graduates in E&E and Mechanical Engineering often receive competitive job offers from international companies or are attracted to industries outside their field of study. This can lead to a brain drain, where the local industry struggles to retain top talent.

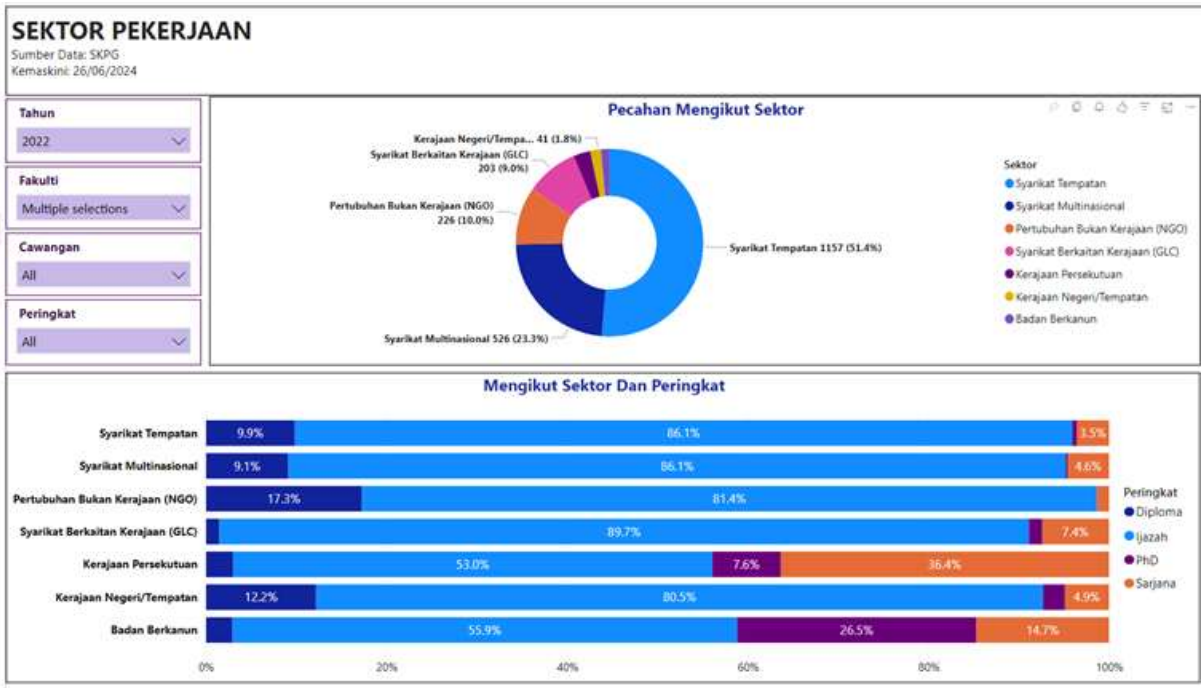


Figure 4.5.2: Snapshot of Employment Outcomes for Graduates by Faculty and Branch, Categorized by Employment Sector (Sistem Kajian Pengesanan Graduan, UiTM Penang Branch retrieved on 26 June 2024).

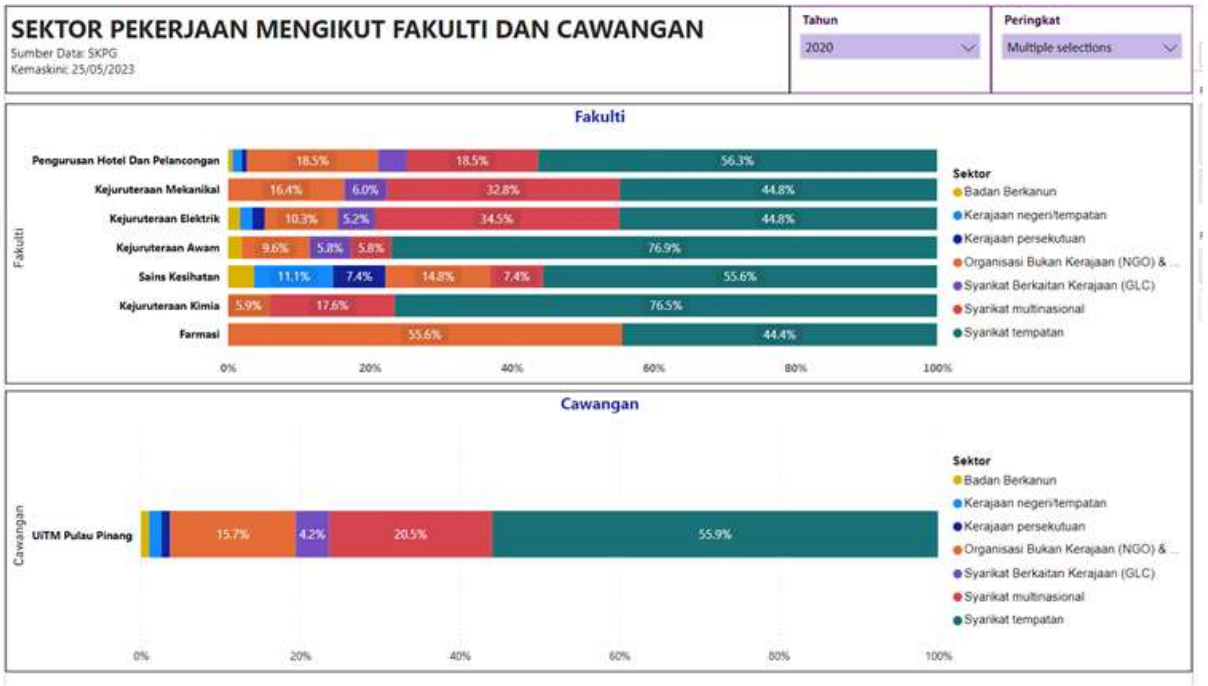


Figure 4.5.3: Employment Distribution of UITM Graduates by Faculty and Department Across Sectors: Government, Private Companies, and Other Organizations (Sistem Kajian Pengesanan Graduan, UiTM Penang Branchretrieved on 26 June 2024).

The graphs as shown in Figures 4.5.2 and 4.5.3 illustrate the employment distribution of graduates from different faculties and a specific department across various sectors, including government, private companies, and other organizations.

Impact to the Firm Performance:
The limited supply of E&E and Mechanical Engineering graduates poses serious challenges for firm performance in Malaysia's electronics and manufacturing sectors. Companies relying on these skilled professionals may face delays in project execution, lower productivity, and a reduced capacity for innovation due to the scarcity of qualified candidates. This talent gap can also lead to increased recruitment costs, as firms may need to offer higher salaries or seek expatriate professionals to fill the void, which could strain financial resources. Additionally, the lack of adequately trained graduates could push companies to outsource more technical work abroad, leading to higher operational costs and potential quality control issues. Over time, the inability to attract and retain skilled engineers may impede firms' competitiveness in the global market, stunting growth and hampering Malaysia's efforts to become a leader in high-value technological industries. Addressing this talent gap is crucial for sustaining industry growth, maintaining competitive advantage, and fostering long-term economic prosperity.

4.6 Case Study 6: Declining Interest in Engineering Among Malaysia's Youth

Introduction:
The declining interest in engineering among Malaysian youth poses a significant threat to the country's long-term industrial and economic aspirations. As Malaysia strives to enhance its presence in high-tech global industries, particularly in the E&E sector, the reduction in STEM enrolment raises concerns about the future talent pipeline. Misconceptions surrounding engineering careers, coupled with negative perceptions of work-life balance, further exacerbate the existing talent gap in critical fields such as engineering. This case study examines the factors contributing to this decline, including educational system shortcomings, societal expectations, and concerns over career prospects and salaries. By addressing these challenges, Malaysia can work toward reversing this trend and developing a stronger pool of engineering talent to support its evolving industrial landscape.

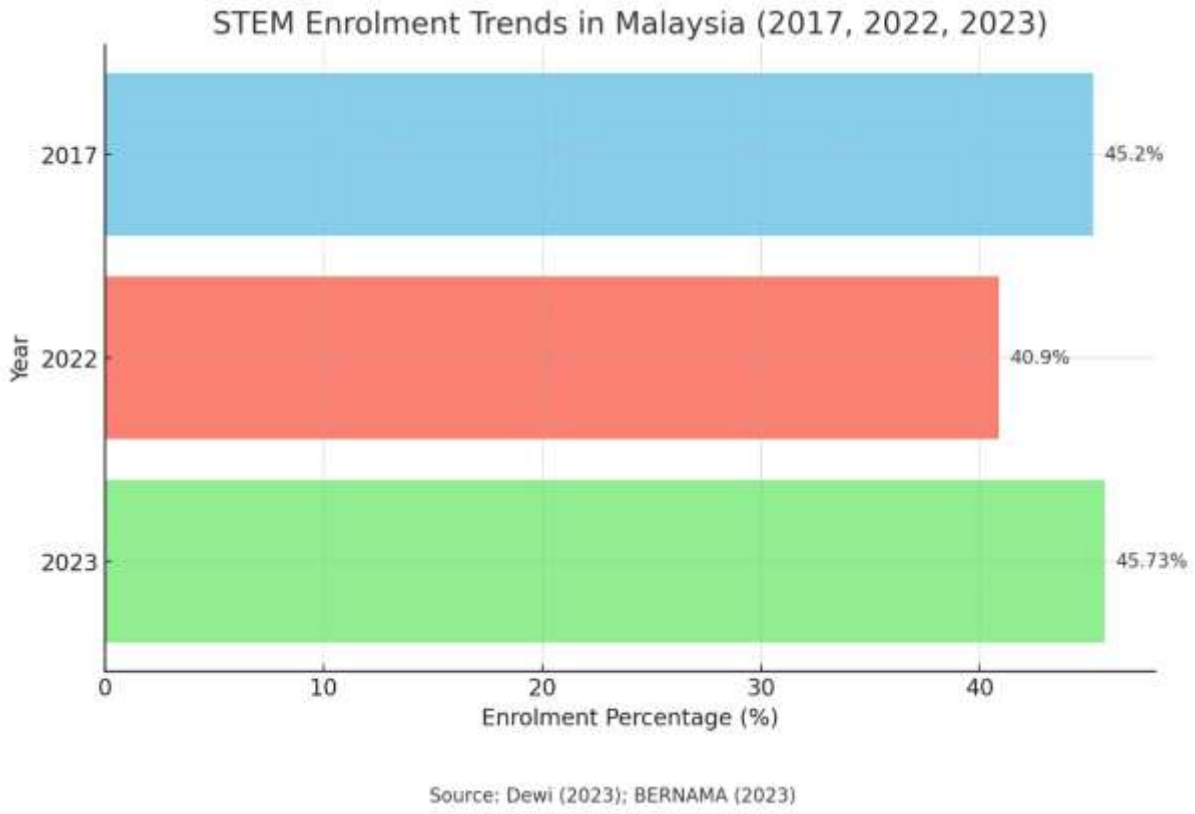


Figure 4.6.1: STEM Enrolment Trends in Malaysia (2017, 2022 and 2023), (Dewi, 2023, BERNAMA, 2023)

Declining Interest in STEM:
In Figure 4.6.1, according to data from the Ministry of Education, the percentage of upper secondary students enrolled in the STEM stream fell from 45.2% in 2017 to 40.9% in 2022, raising alarms about the diminishing interest in these critical fields (Dewi, 2023). However, by August 2023, efforts to reform STEM education had resulted in an increase, with enrolment rising to 45.73% (BERNAMA, 2023).

Although this rise in enrolment is a positive sign, it does not fully resolve the deeper issues that contributed to the earlier decline. Challenges such as societal perceptions, outdated teaching

practices, and academic pressures remain significant barriers. These recent improvements should be viewed as early steps towards addressing the issue, rather than a complete solution. Below are some of the key factors contributing to the ongoing disinterest in engineering.

A. Students' Loss of Interest in STEM:

1. **Focus on Rote Learning and Exams:** The Malaysian education system prioritizes theoretical learning and exams, which often leads to the perception that engineering is overly focused on memorization, hindering creativity and practical exploration. This discourages students from engaging with more hands-on, problem-solving fields like engineering, limiting their creative and analytical development (Toh, 2018; Jasmi, 2023). The lack of experiential learning further reduces exposure to the innovative aspects of engineering, leading to diminished interest.
2. **Intense Academic Pressure:** Academic pressure is a significant concern among Malaysian students. A study conducted by the Ministry of Health in 2015 revealed that the prevalence of mental health problems among adults in Malaysia increased from 10.7% in 1996 to 29.2% in 2015 (Hassan et al., 2022). This rise is particularly pronounced among university students, with factors such as heavy academic workloads, financial difficulties, and family issues contributing to increased stress levels (Kotera, Ting & Neary, 2021). The demanding nature of engineering programs, which require mastery of technical calculations and complex formulas, can exacerbate these stressors, potentially deterring students from pursuing careers in engineering.
3. **Outdated Teaching Methods:** The Malaysia Education Blueprint (2013-2025) critiques the reliance on teacher-centered lectures and rote learning, which fail to engage students in practical, problem-solving activities. It calls for more interactive, student-centered teaching methods that promote higher-order thinking and problem-solving skills (Ministry of Education, 2012). Without these reforms, students are not adequately prepared for real-world challenges, making engineering an unattractive option for many (Adam & Lok, 2022).

B. Societal Perception and Stereotypes:

1. **Emphasis on Traditional Engineering**: The Board of Engineers Malaysia (BEM) continues to prioritize traditional fields such as Civil, Mechanical, Chemical, and Electrical Engineering, giving less recognition to emerging fields like software or biomedical engineering. This narrow focus shapes public perception, leading many to associate engineering primarily with construction and manufacturing industries, limiting interest in more innovative sectors (BEM, 2023). Consequently, fields like environmental engineering or renewable energy receive less visibility, which prevents students from exploring broader opportunities.
2. **Parental and Societal Expectations**: In Malaysia, societal perceptions often favor medicine over engineering as a career choice. A study by Nagandla et al. (2016) found that 52% of Malaysian medical students chose their field due to personal interest, while 48% were influenced by factors such as family expectations and societal prestige. This indicates that societal and familial pressures significantly impact career decisions, with medicine often perceived as more prestigious than engineering These societal pressures steer students away from engineering, despite its critical importance to the nation's technological and industrial development.

C. Work-Life Balance Concerns:

Malaysia's electronics industry, which focuses on labour-intensive activities like assembly and testing, offers few opportunities for high-value work such as research and development or

intellectual property creation. The demanding work environments marked by long hours, high stress, and constant on-call responsibilities further deter youths who prioritize flexible working conditions and work-life balance. Engineering, particularly in fields like manufacturing, is often perceived as lacking in this flexibility, making it less appealing to younger generations who value a healthier work-life balance.

D. Salary Concerns:
The Graduates' Choice Award (GCA) 2023 survey highlights that fresh graduates highly appreciated flexible work arrangements, work-life balance, and competitive salaries. Many graduates expect a starting salary between RM3,000 and RM4,000 to cover their living costs in urban areas. However, the average graduate salary in Malaysia remains between RM2,500 and RM2,700, which falls short of expectations. This salary gap creates a mismatch between what graduates anticipate and what employers are willing to offer, making it difficult for companies to attract top talent (Focus Malaysia, 2023; Ignatius, 2023a). Employers must strike a balance between meeting the evolving expectations of young professionals and maintaining cost-effective operations.

Impact on Firm Performance:
The decline in engineering interest among Malaysia's youth presents a significant challenge for the country's future workforce and industrial development. As fewer students enter engineering and related STEM fields, the talent pool for Malaysia's technology and electronics sectors continues to shrink, leading to increased recruitment costs, longer project timelines, and reliance on less experienced employees. Additionally, the lack of qualified engineers hampers firms' ability to innovate, which ultimately weakens Malaysia's competitiveness in global markets. Without a sufficient pipeline of engineering talent, companies will struggle to maintain productivity, quality, and operational efficiency. To address this, firms and policymakers must collaborate to reform educational curricula, offer incentives to attract youth into engineering, and create a more appealing work environment for young professionals.

By addressing these interconnected challenges, Malaysia can work toward cultivating a more robust pipeline of engineering talent, ensuring its long-term competitiveness in critical sectors like technology and E&E.

4.7 Case Study 7: The Impact of Brain Drain on Malaysia's Engineering Talent Pool

Introduction

The brain drain phenomenon in Malaysia presents a significant challenge, particularly for high-skill sectors such as engineering. Brain drain refers to the emigration of highly educated or skilled individuals seeking better career prospects, higher salaries, and improved living conditions abroad. In Figure 4.7.1, over the past decade, Malaysia has experienced a sharp rise in the number of skilled professionals leaving the country, with 35.9% of the diaspora by 2015 being classified as part of this brain drain, up from 33.4% in 2010 (Lembaga Penduduk dan Pembangunan Keluarga Negara (LPPKN), n.d.). This outflow has adversely affected industries like engineering, where the loss of talent hinders innovation, operational efficiency, and overall competitiveness.

While countries like Singapore and Hong Kong have higher brain drain rates due to their open economies, Malaysia's intensity of brain drain is more concerning when compared to the global average, where Malaysia's rate is more than double (The Star, 2023; Ram, 2023). The engineering sector, which plays a crucial role in Malaysia's economic development, faces serious repercussions from this trend, limiting its capacity to take on high-value projects and remain competitive on a global scale.

This case study explores the causes behind Malaysia's brain drain, particularly in engineering, and examines its impact on firm performance. It also provides recommendations for mitigating the brain drain to strengthen Malaysia's engineering talent pool and support its long-term industrial growth.

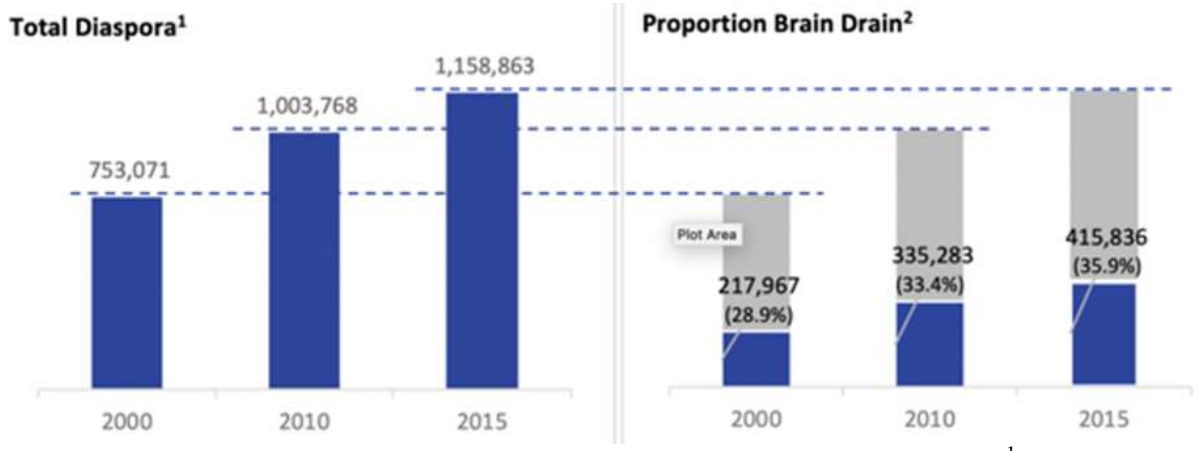


Figure 4.7.1 Diaspora and Proportion Bran Drain (LPPKN, n.d.)[1]

Statistics about the brain Drain

Malaysia is experiencing a critical rise in brain drain, with its intensity doubling the global average. While nations such as Singapore (14.4%) and Hong Kong (29.5%) report higher brain drain rates, these figures align with their small populations and highly open economies (LPPKN, n.d.). Their labour mobility is a natural outcome of their economic structures. In contrast, Malaysia's increasing brain drain is a cause for concern, particularly when

[1] Diaspora refers to the stock of Malaysian-born migrants, regardless of skill profile, aged 0+. Brain drain refers to the stock of tertiary educated Malaysian-born migrants, aged 25+.

benchmarked against global norms. This trend poses significant challenges for talent retention and long-term economic sustainability.

An analysis of the Malaysian diaspora reveals that a substantial proportion of engineering graduates migrate abroad, with Singapore being the primary destination, accounting for 46.9% of the total Malaysian diaspora (see Figure 4.7.2). This overwhelming preference for Singapore can be attributed to its geographic proximity, competitive salaries, and strong demand for skilled professionals. Other key destinations include:

- **Australia (12.5%)** – Attracting Malaysian graduates through its strong education-to-employment pipeline, high living standards, and skilled migration programs.
- **Brunei (9.3%)** – Offering tax-free salaries and opportunities in the oil & gas and engineering sectors.
- **United Kingdom (8.1%)** – A popular choice due to historical ties, high-quality job opportunities, and established Malaysian communities.
- **United States (7.1%)** – Drawing talent with its robust tech and engineering industries.

Collectively, these five countries account for approximately 84% of Malaysia's total diaspora, underscoring a strong preference for developed economies that offer competitive opportunities (LPPKN, n.d.).

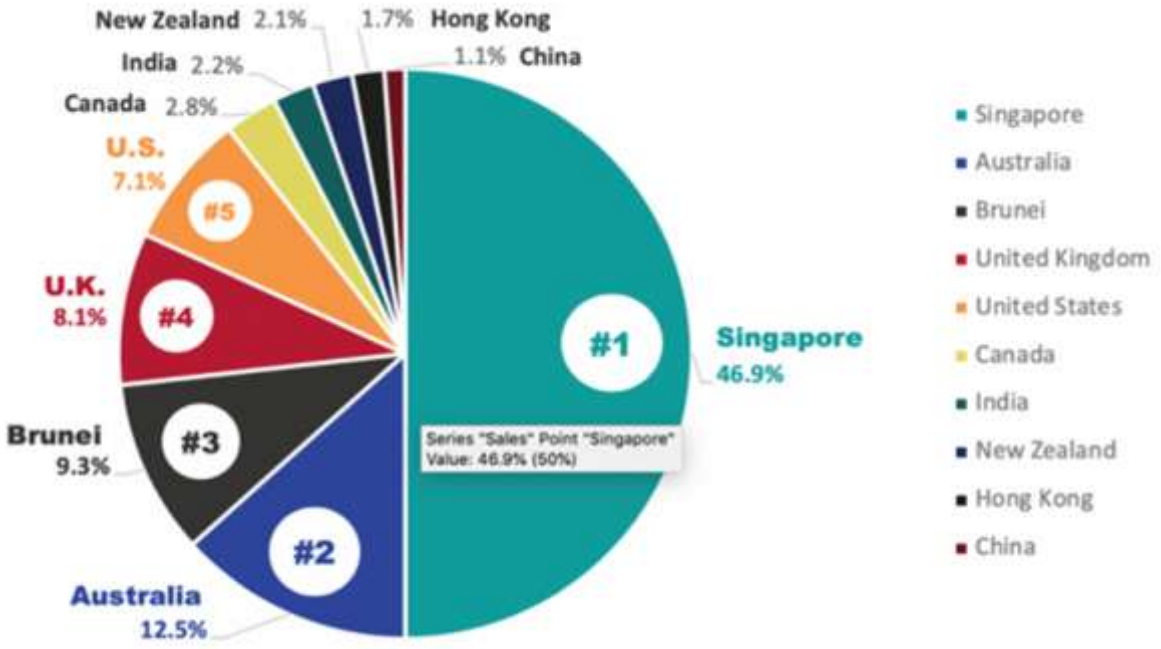


Figure 4.7.2: Top destinations for Malaysian diaspora (% of total Malaysian diaspora), *Source: Ipsos Analysis, based on World Bank Report 2011 (Brain Drain)* (LPPKN, n.d)

Workforce Participation and Labour Market Trends

The data (see Figure 4.7.3) highlights significant gender disparities in labour market participation across skill levels. Among skilled workers, housework, family, and community responsibilities account for 51.0% of women's inactivity, compared to just 1.5% for men, demonstrating a major gender gap in workforce participation. Additionally, a larger proportion of women (32.2%) are engaged in schooling at the skilled level compared to men (59.4%), suggesting that women tend to prioritize education before entering the workforce.

However, in the semi-skilled and low-skilled categories, women face higher inactivity rates due to household responsibilities (58.4% and 62.6%, respectively), compared to men (2.2% and 2.7%). This trend raises concerns about the underutilization of skilled female talent and reinforces the need for policies that support women's workforce participation, such as flexible work arrangements and childcare support. Moreover, while the higher rate of schooling among skilled individuals suggests a strong talent pipeline, it also increases susceptibility to brain drain if local career opportunities fail to meet expectations. Addressing these challenges is crucial for retaining Malaysia's highly educated workforce and ensuring sustained economic growth.

Men:	Skilled	Semi-skilled	Low-skilled
Schooling	99.6 (59.4%)	570.1 (68.3%)	766.0 (66.8%)
Retired	49.0 (29.2%)	125.8 (15.1%)	179.1 (15.6%)
Not Interested	6.9 (4.1%)	23.5 (2.8%)	27.3 (2.4%)
Disabled	4.9 (2.9%)	43.5 (5.2%)	128.2 (11.2%)
Going for Further Studies	4.9 (2.9%)	53.4 (6.4%)	13.9 (1.2%)
Housework/Family/Community Responsibilities	2.5 (1.5%)	18.7 (2.2%)	31.4 (2.7%)

Women:	Skilled	Semi-skilled	Low-skilled
Schooling	109.5 (32.2%)	685.6 (34.5%)	711.9 (29.7%)
Retired	35.0 (10.3%)	61.4 (3.1%)	87.3 (3.6%)
Not Interested	11.7 (3.4%)	8.2 (0.4%)	7.4 (0.3%)
Disabled	1.4 (0.4%)	15.3 (0.8%)	73.8 (3.1%)
Going for Further Studies	9.0 (2.6%)	55.7 (2.8%)	14.1 (0.6%)
Housework/Family/Community Responsibilities	173.4 (51.0%)	1,160.2 (58.4 %)	1,500.2 (62.6%)

Figure 4.7.3: Reason for not seeking work by gender and education qualification (thousand people), Malaysia, 2015 (LPPKN, n.d)

Definitions:(1) Skilled=Diploma, Degrees and equivalent; (2) Semi-skilled=SPM, STPM, Certificates and equivalent; (3) Low-skilled=no certificates, no formal education, UPSR, PMR and equivalent. (128.4 disabled men low-skilled) (Women low-skilled Retired woman, 87.2) Not Interested 7.3, disabled 73.9, further study 14.2.

Gender Pay Disparities

An analysis of salary data (see Figures 4.7.4 and 4.7.5) reveals a notable wage gap between men and women, particularly at senior-level positions. Based on median and mean salary figures, men aged 45 and above earn between RM300 and RM700 more than women in the same age group. The gap is most pronounced in the 60–64 age group, where men earn RM462 (median) and RM668 (mean) more than women.

Across different occupations, men consistently earn higher salaries than women. The largest pay gap is observed among professionals, where men earn RM1,250 (30%) more than women. Similarly, in managerial positions, men earn RM890 (14%) more than their female counterparts. The disparity extends across various fields, including skilled agricultural work, craft and trade, plant and machine operations, and elementary occupations, where men earn between 11% and 46% more than women.

These figures highlight a persistent gender pay gap across both seniority levels and occupational categories, signaling the need for further assessment and policy interventions to promote fair compensation practices.

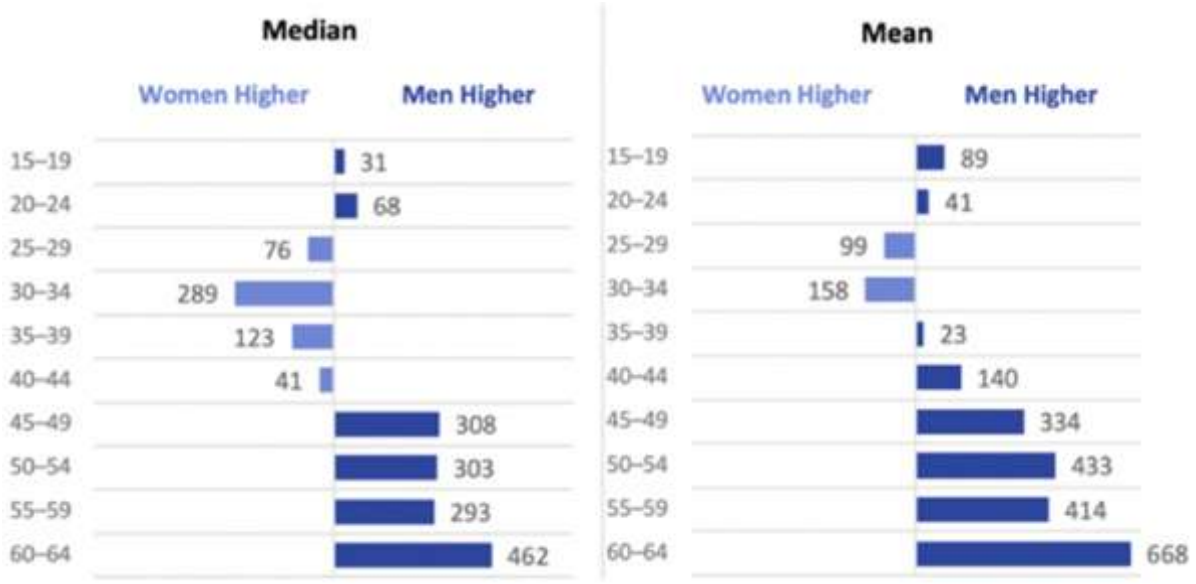


Figure 4.7.4: Salary discrepancy by gender and age (RM), Malaysia, 2012-2016 Aggregated
Source: National Salary and Wages Survey 2012-2016 (LPPKN, n.d.)

Occupation	Men	Women	Women Higher	Men Higher	% Higher
Manager	7,235	6,345		890	14%
Professionals	5,471	4,221		1,250	30%
Technicians & Associate Professionals	3,161	2,835		326	11%
Clerical Support Workers	2,365	2,014		351	17%
Service and Sales Workers	1,867	1,308		559	43%
Skilled Agricultural, Forestry, Livestock and Fishery Workers	1,613	1,107		506	46%
Craft and Related Trade Workers	1,725	1,273		452	36%
Plant and Machine Operators and Assemblers	1,767	1,295		472	36%
Elementary Occupations	1,345	974		371	38%

Figure 4.7.5: Average Salary by Gender and Occupation (RM), Malaysia, 2016
Source: National Salary and Wages Survey 2012-2016. (LPPKN, n.d)

Addressing the Brain Drain Crisis

According to data from 2023, Malaysia's brain drain rate is approximately 5.5% of the population, significantly exceeding the global average of 3.3%. The Human Resources Ministry has acknowledged this trend and is taking steps to address the issue, particularly as the number of Malaysians living abroad has risen from 1.00 million in 2010 to 1.86 million in 2023 (LPPKN, n.d.). A substantial portion of this diaspora amounted 1.13 million individuals who resides and works in Singapore (The Star, 2023; Ram, 2023).

Given the scale of this migration, it is crucial to understand the underlying key reasons driving Malaysia's brain drain.

A. Key reasons that lead to brain drain in Malaysia

1. Economic Factors: Less Competitive Salary and Benefits

A primary cause of brain drain in Malaysia is the uncompetitive salary structure, particularly in high-skill sectors. According to the World Bank, the starting salary for a computer science graduate in the U.S. is approximately USD 50,000, whereas in Malaysia, it is only about USD 10,000. This discrepancy, coupled with the high cost of living and luxury taxes, such as a new Toyota Corolla costing more than double the U.S. price, pushes skilled workers to seek employment overseas where their skills are better compensated.

2. Career Development: Lack of Opportunities in High-Skill Fields

The limited availability of career opportunities, especially in research and development (R&D), is another significant contributor to brain drain. Malaysia's economy is heavily reliant on production and manufacturing, leaving few prospects for engineers and highly skilled professionals. This lack of career advancement options drives talent abroad, where more dynamic and innovation-driven job markets exist, such as in Singapore and Australia, which are major destinations for the Malaysian diaspora.

3. Social Factors: Perceived Social Injustice and Education Barriers

A key social driver of brain drain is the perception of social injustice due to the bumiputera policies. These policies provide Malays with certain privileges, such as business assistance and education quotas, leaving non-Malay professionals, particularly Malaysian Chinese, feeling marginalized. It's estimated that 81% of emigrants are Chinese. This ethnic dimension, combined with limited access to affordable, high-quality education due to racial quotas, further fuels emigration. Dissatisfaction is often expressed in blogs and media by Malaysians abroad, highlighting social inequalities as a significant push factor (Malaysia Push Factor, 2009). Even foreign observers recognize this as a major cause of brain drain, as expressed by former United States ambassador to Malaysia (Malott, 2011).

Less availability of high-quality education is a significant cause of brain drain. Enrolment into affordable public tertiary education institutions is very limited and based on racial quotas while private universities are costly and aren't anywhere near the standards of universities in developed countries. Even though the primary and secondary education is free, they are generally substandard quality and it is usually supported by long hours of outside private tutoring (for those who can afford it).

The vicinity of Singapore and its more developed environment and better living standard also encourages the Malaysian diaspora to migrate there. The nearby advantage of Singapore generally allows them to keep in touch with families left behind in Malaysia, and the large

community of Malaysians already based there over the last six decades make it much easier for them to move over.

B. Impact on Firm Performance and Key Sectors

The brain drain has particularly harmed Malaysia's engineering and technology sectors. Firms struggle to fill high-skill positions, leading to delays in project timelines and reliance on less experienced staff. This is especially problematic for industries such as electronics and semiconductors, which require specialized knowledge. Without a sufficient talent pool, companies face reduced innovation, weakened operational efficiency, and diminished competitiveness in international markets. This impacts both productivity and the country's ability to take on complex, high-value projects that are critical to economic growth.

C. Solutions and Policy Recommendations

To reverse the brain drain and mitigate its impact on industries, the following measures should be prioritized:

1. **Increase Salary Competitiveness**: The government should work with the private sector to create competitive salary packages that reflect international standards, especially in high-skill areas such as technology and engineering. Offering tax incentives to firms that raise wages for skilled workers could be a way to offset the initial cost of wage increases.
2. **Enhance Career Development Opportunities**: Malaysia needs to foster a more innovation-driven economy by encouraging R&D investment and creating more high-value job opportunities. Building research hubs and incentivizing businesses to engage in R&D will provide skilled workers with career paths that match their qualifications.
3. **Improve Access to High-Quality Education**: Reforms to ensure merit-based access to education are essential for retaining top talent. Expanding scholarship programs and improving the quality of public universities will help to address the current disparities in education and create a more equitable system.
4. **Address Social Inequality**: Re-evaluating policies that disproportionately benefit certain ethnic groups can help create a more inclusive society. Reducing ethnic-based quotas in education and employment will ensure that talent is nurtured and retained, regardless of background.

Conclusion

Brain drain poses a significant threat to Malaysia's ability to build a competitive and innovative economy, especially in fields like engineering and technology. Addressing the key drivers of this trend uncompetitive salaries, limited career prospects, and social inequalities will be essential for retaining top talent and ensuring the country's long-term economic growth. By implementing policies that focus on creating a more equitable and opportunity-rich environment, Malaysia can mitigate the effects of brain drain and build a more resilience, sustainable, and skilled workforce.

4.8 Case Study 8: Navigating Regulatory Hurdles in Malaysia's Electronics Sector

Introduction:
Lingkail Sdn Bhd, a Malaysian software development company, seeks to expand its technical expertise by hiring a qualified expatriate software engineer. The company director, eager to streamline the recruitment process, initiates an online application through the portal recommended by initial research – https://esd.imi.gov.my/portal/. However, this seemingly straightforward path quickly unravels into a labyrinthine journey through multiple government agencies.

The Bureaucratic Maze:
According to the ESD portal, the Expatriate Services Division (ESD) under the Immigration Department of Malaysia committed to delivering "efficient, effective, and innovative services" to facilitate expatriate hiring. However, Lingkail's director soon discovers this claim to be far from reality. After weeks of waiting for a response to their online application, the company learns that applications for software engineers must be submitted through the Malaysian Development Corporation's (MDEC) portal – https://mdec.my/expats.

While navigating the MDEC portal, Lingkail encounters yet another detour. The application process redirects them to the Ministry of Human Resources (MOHR) portal – http://www.eppax.gov.my/, managed by the Department of Labour Peninsular Malaysia (JTKSM). This information is only revealed through manual intervention – contacting MDEC personnel directly. (reference: https://mdec.my/expats/announcement/update-on-registration-with-department-of-labour-peninsular-malaysia-jtksm)

This intricate network of portals demonstrates a significant disconnect between government agencies involved in the expatriate hiring process. Each step creates delays, requiring the director to invest significant time and effort deciphering the complex routing and manually contacting personnel for clarification.

Impact and Implications:
The bureaucratic hurdles faced by Lingkail highlight several critical issues in Malaysia's current system for hiring foreign talent:

- **Inefficiency:** The process is unnecessarily time-consuming, hindering companies seeking to fill critical positions.
- **Lack of Transparency:** The information about the required application path and responsible agencies is not readily available on the initial ESD portal, leading to confusion and delays.
- **Inconsistent Communication:** The redirection process within the MDEC portal relies on manual intervention rather than a seamless transfer between platforms.
- **Administrative Burden:** The fragmented process places a significant burden on companies, requiring them to navigate multiple portals, submit duplicate documentation, and directly contact officials for clarification.

These issues discourage companies from hiring foreign talent, hindering Malaysia's efforts to attract skilled professionals and foster a dynamic, knowledge-based economy. Additionally, the delays and difficulties can discourage qualified expats from pursuing opportunities in Malaysia, impacting the country's ability to compete globally.

Recommendations:
To streamline the expatriate hiring process and improve Malaysia's attractiveness for foreign talent, several steps can be taken:

- **Centralized Platform:** Develop a single, unified online portal that consolidates all application procedures for different types of expatriate work permits. This platform should offer clear instructions, facilitate seamless transfers between relevant agencies, and provide real-time application status updates.
- **Enhanced Transparency:** Provide comprehensive information on the application process, including the required steps, necessary documents, and responsible agencies. This information should be readily accessible and consistently communicated across all government portals.
- **Inter-agency Coordination:** Establish robust communication and data exchange mechanisms between the Immigration Department, MDEC, and MOHR to ensure a smooth application flow and eliminate the need for manual intervention.
- **Improved Efficiency:** Streamline the approval process by reducing the number of steps and minimizing unnecessary documentation requirements. Implement electronic document verification and utilize technology to expedite approvals.

The case of Lingkail Sdn Bhd illustrates the challenges companies face when attempting to hire skilled expatriates in Malaysia. By streamlining the process and fostering inter-agency collaboration, the Malaysian government can create a more efficient, transparent, and user-friendly system for attracting and retaining valuable foreign talent. This will not only benefit businesses seeking to expand their expertise but also contribute to Malaysia's economic growth and global competitiveness.

Impact to the Firm Performance:
The bureaucratic hurdles encountered by Lingkail Sdn Bhd not only caused delays in the expatriate hiring process but also had significant implications for the company's overall performance. The extended timeframes and administrative burdens led to increased operational costs, requiring the company to allocate additional resources to navigate the complex, multi-step process effectively. Moreover, the inability to quickly hire the needed technical talent hindered Lingkail's ability to meet project deadlines, affecting both productivity and client satisfaction. This delay in securing skilled foreign expertise could result in missed opportunities for innovation and growth, potentially reducing the firm's competitive edge in the fast-evolving software development industry. In the long run, such inefficiencies can slow the firm's expansion efforts, impact revenue, and harm its reputation in the highly competitive tech sector. Therefore, addressing these regulatory inefficiencies is crucial for improving firm performance and fostering a more dynamic and globally competitive business environment in Malaysia.

4.9 Case Study 9: Regulatory Delays and Their Impact on Supply Chains – The Experience of Beye

Introduction:
Beye, a prominent aluminium trading company, serves a critical role in the supply chain of Malaysia's thriving electronics industry. By supplying aluminium to industrial automation companies, Beye ensures the uninterrupted production of essential electronic components. However, the company faced a significant setback when a regulatory bottleneck disrupted its operations, highlighting the vulnerabilities of supply chains reliant on government bureaucracy and industry adaptation.

The Challenge:
Aluminium imports into Malaysia are subject to stringent regulations imposed by the government. The Standards and Industrial Research Institute of Malaysia (SIRIM) plays a pivotal role in auditing and approving imported aluminium grades. While this regulatory framework is designed to safeguard product quality and safety, it can also create unforeseen challenges for businesses operating in a dynamic global market.

In a specific instance, Beye encountered a critical issue when an aluminium grade previously approved by SIRIM became obsolete on the global market. Despite the widespread adoption of the newer grade, SIRIM failed to update its regulations, resulting in a prolonged approval process for the imported material.

The delay in obtaining SIRIM's approval caused a severe disruption to Beye's supply chain. The aluminium shipment remained stranded in the port warehouse for an extended period, incurring substantial storage fees and incurring significant financial losses. The inability to deliver the critical aluminium component to its industrial automation clients led to production delays, affecting the entire electronics supply chain.

Impact on the Supply Chain:
The incident underscores the profound impact that even a single point of failure can have on a complex supply chain. The electronics industry, characterized by its intricate network of interconnected businesses, is particularly vulnerable to disruptions in the supply of raw materials.

Beye's experience highlights several key challenges:

- **Regulatory Rigidity:** The slow pace of regulatory updates can hinder businesses' ability to adapt to rapidly changing market conditions.
- **Supply Chain Vulnerability:** Reliance on a single source for a critical component exposes the supply chain to significant risks.
- **Financial Loss:** Delays and disruptions can result in substantial financial losses for businesses at all levels of the supply chain.
- **Customer Dissatisfaction:** Production delays caused by supply chain disruptions can lead to customer dissatisfaction and loss of market share.

Implications for the Electronics Industry:
The case of Beye underscores the need for greater flexibility and agility in the management of supply chains within the electronics industry. To mitigate risks and ensure business continuity, several strategies can be considered:

- **Diversification:** Reducing reliance on a single supplier or source of raw materials can help to mitigate supply chain disruptions.
- **Inventory Management:** Maintaining adequate inventory levels of critical components can provide a buffer against unexpected shortages.
- **Risk Assessment:** Regularly assessing potential risks and developing contingency plans can help businesses prepare for unforeseen challenges.
- **Regulatory Advocacy:** Industry associations can play a role in advocating for regulatory reforms that promote flexibility and adaptability.

The aluminium import impasse experienced by Beye serves as a stark reminder of the challenges faced by businesses operating in a complex and interconnected global economy. While regulations are essential for ensuring product safety and quality, they should not stifle innovation and economic growth.

By adopting a more proactive and flexible approach to regulation, governments can create a more conducive environment for businesses to thrive. Ultimately, building resilient supply chains requires a collabourative effort involving government agencies, industry stakeholders, and businesses. By working together, it is possible to mitigate risks, reduce disruptions, and ensure the continued growth and prosperity of the electronics industry.

Impact to the Firm Performance:
The regulatory delays experienced by Beye not only impacted its immediate supply chain but had far-reaching consequences on its overall firm performance. The prolonged hold on aluminium imports led to significant financial losses due to storage fees and delayed sales. These disruptions affected Beye's ability to meet customer demands, resulting in production delays and a weakened relationship with key clients in the electronics industry. Such operational inefficiencies can lead to a loss of trust and customer dissatisfaction, ultimately hurting Beye's market reputation. Additionally, the inability to promptly deliver products caused a loss of competitive advantage, as competitors could potentially fill the market gap during periods of disruption. Over time, these factors could erode market share, reduce profitability, and hinder Beye's growth prospects.

To remain competitive, firms like Beye must ensure that their supply chains are resilient and capable of responding to regulatory challenges, while also leveraging strong relationships with regulatory bodies to prevent such incidents from recurring. By doing so, they can better protect their firm performance and maintain their industry standing.

4.10 Case Study 10: Violations of RBA Standards in Malaysia's Electronics Industry

In Malaysia's electronics industry, there have been significant violations of the Responsible Business Alliance (RBA) standards, particularly concerning the treatment of migrant workers. These violations raise serious concerns about working conditions, including issues of forced labour and exploitation. One notable incident involved Samsung's supply chain in Malaysia.

Following an investigation by Pattisson (2018), Samsung was found to have engaged in practices such as passport retention, high recruitment fees, and providing substandard living conditions for migrant workers. Although Samsung implemented corrective actions after these issues were brought to light, this incident underscores the ongoing challenges that persist in Malaysia's electronics sector. Hence, RBA-approved audits conducted by firms like TÜV SÜD in Malaysia have continued to identify violations of labour standards, indicating that challenges in worker treatment, particularly for migrant labourers, persist across the industry.

Forced labour remains a widespread issue, with frequent violations of the RBA Code of Conduct. The RBA Code sets high standards for worker health, safety, and fair treatment. Violations such as forced overtime, wage withholding, and unsafe working environments have been reported throughout the electronics supply chains. For example, TÜV SÜD Malaysia conducts RBA audits to identify such violations in factories, ensuring that corrective actions are taken when forced labour or poor working conditions are detected (TÜV SÜD, n.d.).

Two notable incidents are explored below:

Incident 1: ATA IMS and Labour Violations
Introduction:
ATA IMS, a contract manufacturer for Dyson, was implicated in a significant case of RBA violations involving exploitative labour practices, particularly affecting migrant workers (Kashyap, 2022; Business & Human Rights Resource Centre, 2022).

The Challenges:
ATA IMS supplied parts for Dyson's vacuum cleaners and other products but faced serious allegations of forced labour and substandard working conditions. Issues included excessive working hours, unpaid wages, and workers living in inadequate housing. Migrant workers from countries such as Bangladesh and Nepal were particularly affected, with some being employed without proper work permits.

In 2021, following an independent audit and whistle-blower allegations, Dyson announced its decision to terminate its relationship with ATA IMS. The audit revealed extensive labour violations, including worker exploitation and concerns over retaliation against those who raised complaints. Dyson, which contributed significantly to ATA's revenue, provided a six-month notice for termination to allow time for corrective actions and an orderly withdrawal.

Impact on the Supply Chain:
This case drew significant attention, not only for its impact on the affected workers but also for exposing broader issues of labour exploitation within Malaysia's electronics sector, which relies heavily on migrant labour.

Implications for the Electronics Industry:
Following Dyson's decision, ATA's stock plummeted, and the case became a symbol of the increasing scrutiny Malaysian manufacturers face for labour rights violations.

Incident 2: First Solar and Forced Labour Violations
Introduction:
First Solar, a leading U.S. solar panel manufacturer, came under scrutiny for forced labour violations at its Malaysian manufacturing facility (Kennedy, 2023; Ignatius, 2023b; Tan, 2023).

The Challenges:
A third-party audit, referenced in First Solar's 2023 sustainability report, uncovered unethical labour practices by four subcontractors at the Malaysian plant. Migrant workers were charged recruitment fees, had their passports withheld, and faced illegal wage deductions. These practices directly violated RBA standards, which emphasize ethical recruitment, fair wages, and worker protection.

In response, First Solar took immediate corrective actions, including returning workers' passports, reimbursing unlawfully deducted wages, and implementing measures to prevent future violations. The company also partnered with external organizations to develop a plan for reimbursing recruitment fees and committed to ongoing monitoring to ensure compliance with labour standards. These actions reflect First Solar's dedication to transparency and ethical labour practices.

Impact on the Supply Chain:
This case highlights the persistent issue of labour abuses in the solar industry, despite the sector's efforts to transition to more sustainable energy sources. Challenges remain in enforcing labour standards, particularly in supply chains. It is estimated that only 20-30% of large electronics manufacturers in Malaysia will be able to fully comply with RBA, Carbon Border Adjustment Mechanism, EU (CBAM,) and Corporate Sustainability Due Diligence Directive, EU (CSDDD) regulations by 2026. Without substantial support and investment, small and medium-sized enterprises (SMEs) will struggle significantly.

Implications for the Electronics Industry:
In response to these regulatory pressures, many companies may opt to either shift operations or reduce their exposure to the European Union market rather than face non-compliance penalties.

Impact to the Firm Performance:
The violations of RBA standards in Malaysia's electronics sector have significant implications for firm performance, both in the short and long term. Labour violations, such as those seen with ATA IMS and First Solar, can damage a company's reputation, leading to decreased investor confidence and stock devaluation, as seen with ATA IMS after Dyson's termination of its contract. Additionally, these violations disrupt supply chains, leading to production delays, increased operational costs, and financial losses due to fines or legal actions. For instance, First Solar's need to implement corrective measures and reimburse unlawfully deducted wages added unforeseen costs, impacting profitability.

Moreover, such issues can lead to a loss of business partnerships and strained client relationships, as global brands often distance themselves from suppliers implicated in unethical labour practices. This negatively affects firms' market competitiveness, especially in regions

with strict regulatory frameworks such as the EU, where non-compliance could result in exclusion from certain markets. Furthermore, companies failing to comply with RBA standards may experience operational inefficiencies due to workforce instability and legal challenges, further hampering their performance and ability to compete internationally.

In the long run, the inability to address these issues may cause firms to lose out on major business opportunities, tarnish their brand, and affect their sustainability in the global electronics supply chain.

4.11 Case Study 11: When Home Feels Distant – A Malaysian Diaspora's Reflection

In 2003, Mr. C graduated from Universiti Teknologi Malaysia (UTM) with a degree in chemical engineering. Like many ambitious young Malaysians, he looked across the causeway to Singapore in search of opportunity. The decision was practical. Singapore offered better currency conversion, strong job prospects in high-tech industries, and a performance-driven work culture that rewarded merit.

Just six months into his first job as a project engineer in the semiconductor industry, Mr. C was granted Permanent Resident (PR) status by the Singapore government. With that status came access to a lower, progressive income tax system and several benefits such as public housing eligibility. In 2017, he purchased a government-subsidized HDB flat in the north of Singapore, cementing his long-term roots across the border with his family.

Over the years, Mr. C built a fulfilling career in Singapore's advanced manufacturing sector. He rose to the position of project manager, overseeing complex facility and engineering projects. While his work took place in Singapore, his heart never left Malaysia. He often thought about returning one day, not necessarily to build a second career, but to retire peacefully. Penang, with its familiar culture and slower pace, seemed like an ideal destination.

In 2024, Mr. C's employer offered him the chance to support a semiconductor construction project in Penang for nine months. The offer was temporary but meaningful. It was a rare opportunity to reconnect with home and assess the professional landscape after being abroad for more than two decades. His salary and benefits continued to be managed by the Singapore company, which meant his income technically derived from overseas employment but was sourced from Penang.

However, his experience on the ground in Penang revealed unexpected challenges. First came the tax treatment. Although he is a Malaysian citizen who resided in Malaysia for over 180 days, Mr. C was classified as a non-resident for tax purposes during Malaysia's Year of Assessment 2025. According to the tax agent, the classification was due to difficulties in confirming his residency data. This resulted in a flat 30 percent tax rate which significantly higher than what he was accustomed to in Singapore. He later discovered that Malaysia had a Returning Expert Programme (REP), which could have reduced his tax burden to 15 percent. Unfortunately, he was unaware of the program before his assignment began. In fact, throughout his entire professional journey in Singapore, no Malaysian government agency had ever contacted him, nor were there visible campaigns or outreach programs designed to engage overseas Malaysians.

This silence stood in contrast to what he heard from peers of other nationalities. Professionals from China and India often shared experiences of being invited to national forums, offered repatriation packages, or provided with streamlined government services upon returning home. The visibility of these efforts became particularly prominent during the Trump administration in the United States, when several reputable scientists returned to their countries of origin. Mr. C noted that Malaysia lacked a comparable ecosystem. He felt that the government remained focused only on its domestic population, with a blind spot that no structured strategy to reconnect with its global talent pool.

In the workplace, Mr. C observed deeper differences. He was there to support the Penang team, not lead, but he quickly noticed a gap in work culture. There was a general lack of urgency in execution, a tendency to avoid accountability, and a reluctance to embrace continuous

improvement. While the facilities were modern and the project scope ambitious, execution suffered due to inconsistent work attitudes. This made it difficult to maintain the operational discipline he was used to in Singapore, and it dampened the overall productivity of the assignment.

Socially and culturally, Mr. C managed well. Language was not a barrier, and local customs were familiar. He still cherished the food, the friendliness of the people, and the laid-back environment of Penang. In fact, the slower pace of life reaffirmed his long-standing desire to retire there. Yet professionally, he concluded that Malaysia might not be the right place to continue building a career, at least not for someone used to a high-performance, globally competitive environment.

When the nine-month assignment ended, Mr. C returned to Singapore with mixed emotions. He felt disappointed that his home country had no clear pathway for people like him to contribute meaningfully. Despite his credentials, experience, and desire to reconnect, there was no invitation, no structure, and no policy that welcomed him back.

His conclusion was clear: Malaysia is a good place to retire, but not a place to build a career, especially for returning diaspora professionals who have experienced global standards.

Key Takeaways:

Early Migration, Long-Term Integration Abroad

Mr. C obtained PR status in Singapore in 2003 and eventually purchased a government flat in 2017. He enjoyed stable, low-tax employment and professional growth, making Singapore his long-term base.

Temporary Return, Permanent Disconnect

Despite being a Malaysian citizen who resided in Malaysia for over 180 days, Mr. C was taxed as a non-resident during YA 2025. He was unaware of tax relief programs like the Returning Expert Programme, highlighting Malaysia's weak outreach to its diaspora.

Absence of Government Engagement

Over two decades, Mr. C received no communication or interaction from any Malaysian agency. This lack of engagement made it clear that the government's focus remained inward, with no evident intent to attract or support returning professionals.

Workplace Cultural Gap

Mr. C observed a significant difference in working attitudes. Flaws in accountability, pace, and quality of execution made it difficult for someone trained in high-performance environments to adapt or contribute effectively.

Retirement Potential, Not Career Growth

Malaysia, especially Penang, remains appealing as a retirement destination for overseas Malaysians. However, without strategic reforms, it is unlikely to attract its diaspora back for professional reintegration or national development.

Conclusion:

Mr. C's experience highlights a critical disconnect between Malaysia's potential to benefit from its global talent pool and its current lack of engagement infrastructure. The absence of outreach, rigid tax treatment, and workplace cultural gaps all contribute to a broader perception that

returning is more of a sacrifice than an opportunity. To transform Malaysia into a country where its diaspora can not only retire but also thrive professionally, a coherent strategy of inclusion, incentive, and integration must be developed and implemented at the national level.

4.12 Qualitative Phase: Case Selection, Data Collection, and Analysis

We employed a purposive, maximum-variation sampling strategy to assemble 11 case studies spanning key nodes of Malaysia's E&E ecosystem (materials and components suppliers, EMS/assembly, standards/compliance contexts, and MNC–SME interfaces). Cases were selected on two criteria:

(i) clear relevance to at least one focal domain: innovation capacity (IP), talent management (TM), or the regulatory environment (RE), and
(ii) availability of a knowledgeable subject-matter expert (SME) and triangulable documentation.

Data were gathered through written contributions (Case 1-7, 11) and SME interviews (Case 8-10), supplemented by company documents, public reports, and regulatory/press sources. For each case, researchers produced an analytic memo. Cross-case matrices were used to identify convergent and divergent patterns. Cross-case synthesis (brief):

(i) *Innovation bottlenecks (Case 1-3):* high capex and weak industry–research linkages slowed frontier adoption, yet pockets of success (e.g., Industry 4.0 adopters; the GaN initiative supported via public–private programs) showed measurable performance gains when support was coordinated.
(ii) *Talent constraints (Case 4-7, 11):* persistent engineering shortages, skills mismatch, and high turnover raised costs and limited scale-up; firms with structured upskilling partnerships moved faster.
(iii) *Regulatory friction (Case 8-10)*: standards/approvals lag (e.g., the "Beye" materials case) and RBA/ESG lapses created supply disruptions and client risk; where single-window processes or rapid standards alignment existed, time-to-market improved. These insights informed construct operationalization and the survey hypotheses in the quantitative phase.

Before proceeding to recommendations, Section 4.12 will provide a qualitative analysis across the cases to identify common factors influencing firm performance. This will ensure that the lessons from these individual cases are integrated and form a coherent basis for the strategic recommendations in Chapter 5. This section synthesizes insights from the case studies to analyze how the factors of innovative performance (IP), talent management (TM), and regulatory environment (RE) influence firm performance, qualitatively. By examining patterns across the diverse cases, we can identify which independent variables (factors) consistently emerge as critical and how they interrelate, ultimately affecting the dependent variable (firm performance, FP).

4.12.1 Qualitative Analysis for Case Study 1 (CS1)

Based on the qualitative study of Gallium Nitride (GaN) technology adoption in Malaysia's electronics sector, the independent variable (IV) and dependent variable (DV) can be identified as follows:

Independent Variable:

The **independent variable** in this case study is the **adoption of GaN technology**. This includes the factors influencing GaN technology integration, such as advancements in GaN research, the development of 300 mm GaN power wafers, strategic partnerships, government support, and the challenges in manufacturing and logistics infrastructure. The variables cover both technological innovations and external factors like regulatory support, financial resources, and market conditions.

Dependent Variable:
The **dependent variable** is the **firm performance** in relation to its ability to integrate GaN technology into its operations. This encompasses improvements in product efficiency, enhanced competitiveness in global markets, increased revenue opportunities, and potential risks such as operational inefficiencies, skills gaps, and supply chain vulnerabilities. The dependent variable reflects the overall impact of GaN technology adoption on a firm's market share, cost efficiency, innovation potential, and long-term growth in the electronics sector.

This qualitative analysis emphasizes how the effective adoption of GaN technology can lead to substantial improvements in firm performance, provided that companies manage the associated challenges and leverage the available support systems to optimize their operations and technological advancements.

4.12.2 Qualitative Analysis for Case Study 2 (CS2)

Based on the qualitative study of advancements in AI and quantum computing, the independent and dependent variables in this context are as follows:

Independent Variable:
The **independent variable** in this study is the **adoption and integration of AI and quantum computing technologies**. This encompasses various factors influencing the implementation of these technologies, such as technological advancements, infrastructure development, cost considerations, talent availability, government initiatives, and market demands. The focus is on how these variables drive the integration of AI and quantum computing into business operations and influence their capabilities.

Dependent Variable:
The **dependent variable** is the **firm performance** as influenced by the adoption of AI and quantum computing. This includes outcomes related to operational efficiency, decision-making capabilities, cost reduction, productivity, and overall competitiveness in the market. Companies that successfully integrate these technologies stand to gain significant advantages in terms of innovation, speed to market, and improved product offerings, while those lagging in adoption may face challenges in staying competitive and achieving growth.

This analysis highlights the critical role that AI and quantum computing play in shaping firm performance, emphasizing the need for businesses to invest in technology, infrastructure, and skilled talent to leverage these advancements effectively.

4.12.3 Qualitative Analysis for Case Study 3 (CS3)

Based on the qualitative study of smart manufacturing in Malaysia, the independent and dependent variables can be identified as follows:

Independent Variable:
The **independent variable** in this study is the **adoption and integration of smart manufacturing technologies**. This includes the implementation of advanced technologies such as AI-driven predictive maintenance, automation, 3D packaging, machine learning, data analytics, and energy-efficient manufacturing practices. It also encompasses factors like government support, industry-academia collaborations, workforce development initiatives, and investment in research and development (R&D) aimed at enhancing manufacturing processes and power management capabilities.

Dependent Variable:
The **dependent variable** is the **firm performance** in the context of the manufacturing sector, particularly in Malaysia's semiconductor industry. This involves metrics such as operational efficiency, resource optimization, productivity, cost reduction, energy management, and overall competitiveness in the market. Companies that successfully implement smart manufacturing techniques are expected to see increased efficiency, reduced downtime, and enhanced innovation, while those lagging in adoption may encounter higher costs, supply chain issues, and diminished market positioning.

This analysis illustrates how the strategic adoption of smart manufacturing technologies significantly impacts firm performance, highlighting the importance of digital transformation, collaboration, and workforce development for maintaining competitiveness in the evolving manufacturing landscape.

4.12.4 Qualitative Analysis for Case Study 4 (CS4)

Based on the qualitative study of talent development challenges in Malaysia's electronics industry, the independent and dependent variables can be identified as follows:

Independent Variable:
The **independent variable** in this study is the **availability and development of talent in the E&E industry**. This includes factors such as the supply of skilled engineers, technical graduates, government initiatives for talent development, educational infrastructure, industry-academia collaboration, and the specific demand for roles like IC design engineers, embedded systems engineers, and software engineers. The focus is on how these variables influence the talent pool in Malaysia's E&E sector.

Dependent Variable:
The **dependent variable** is the **firm performance** within the E&E sector, which is directly impacted by the talent shortages. This involves outcomes such as decreased revenue, delayed project timelines, increased operational costs, missed opportunities in R&D and Industry 4.0 implementation, and difficulties in adopting advanced technologies like IoT and smart manufacturing. The shortage of skilled professionals restricts firms' ability to innovate, compete globally, and contribute to Malaysia's economic and technological advancements.

This analysis highlights the crucial link between talent availability and firm performance, emphasizing the need for strategic talent development initiatives to ensure sustained growth and competitiveness in Malaysia's electronics and semiconductor industries.

4.12.5 Qualitative Analysis for Case Study 5 (CS5)

Based on the qualitative study of the talent gap in Malaysia's E&E and Mechanical Engineering sectors, the independent and dependent variables can be identified as follows:

Independent Variable:
The **independent variable** in this study is the **supply of E&E and Mechanical Engineering graduates**. This includes factors influencing the supply, such as declining student enrolment in STEM fields, rapid technological advancements, the disconnect between academia and industry, a lack of practical experience, outdated curricula, inadequate resources in educational institutions, and economic factors like competitive salaries from international firms attracting graduates away from local industries.

Dependent Variable:
The **dependent variable** is the **firm performance** in sectors that heavily rely on engineering talent, such as electronics and manufacturing. This encompasses impacts such as project delays, reduced innovation capacity, increased recruitment and training costs, lower productivity, and a need to outsource technical work or hire expatriates. These factors ultimately affect firms' ability to remain competitive, drive growth, and meet industry demands.

This analysis underscores how the shortage of qualified graduates in engineering fields significantly hampers firm performance, emphasizing the need for strategic improvements in STEM education, industry-academia collaboration, and retention of local talent to ensure sustainable growth in Malaysia's technology-driven industries.

4.12.6 Qualitative Analysis for Case Study 6 (CS6)

Based on the qualitative study of the declining interest in engineering among Malaysian youth, the independent and dependent variables can be identified as follows:

Independent Variable:
The **independent variable** in this study is the **factors influencing interest in engineering careers among Malaysian youth**. These factors include the educational system's focus on rote learning, outdated teaching methods, societal perceptions and stereotypes regarding engineering, misconceptions about work-life balance, concerns over career prospects and salaries, and declining STEM enrolment rates. These variables shape the perception of engineering as a career choice and influence students' decisions to pursue or avoid engineering fields.

Dependent Variable:
The **dependent variable** is the **firm performance and future talent pipeline** in Malaysia's technology and electronics sectors. The decline in interest in engineering leads to a shrinking talent pool, which impacts firms' abilities to recruit qualified engineers, resulting in increased recruitment costs, longer project timelines, reduced innovation capacity, and a dependency on less experienced employees. These challenges ultimately weaken firms' productivity, competitiveness, and their capacity to drive technological advancements in the global market. This analysis highlights the critical connection between declining interest in engineering and the challenges faced by industries in Malaysia, emphasizing the need for educational reforms, societal attitude shifts, and improved career incentives to build a stronger engineering talent pipeline for sustained economic growth.

4.12.7 Qualitative Analysis for Case Study 7 (CS7)

Based on the qualitative study of the impact of brain drain on Malaysia's engineering talent pool, the independent and dependent variables can be identified as follows:

Independent Variable:
The **independent variable** in this study is the **factors driving brain drain** among Malaysia's engineering professionals. These factors include uncompetitive salary structures, limited career development opportunities, social inequalities due to bumiputera policies, lack of access to high-quality education, and economic disparities. Additionally, the geographical proximity to countries like Singapore, which offers better job opportunities and higher living standards, further exacerbates the brain drain phenomenon.

Dependent Variable:

The **dependent variable** is the **firm performance and talent availability** in Malaysia's engineering and technology sectors. The emigration of skilled professionals leads to challenges such as a reduced talent pool, project delays, reliance on less experienced staff, and diminished innovation capacity. This negatively impacts firms' productivity, operational efficiency, and ability to compete globally, hindering their capacity to take on high-value projects and drive economic growth in high-tech industries.

This analysis highlights the significant link between the causes of brain drain and the negative impact on Malaysia's ability to sustain a competitive and innovative engineering sector, emphasizing the need for strategic reforms to retain top talent and support long-term industrial development.

4.12.8 Qualitative Analysis for Case Study 8 (CS8)
Based on the qualitative case study analysis of Lingkail Sdn Bhd's experience in navigating regulatory hurdles in Malaysia's electronics sector, the independent and dependent variables in this context can be identified as follows:

Independent Variable:
The **independent variable** in this study is the **regulatory process for hiring expatriates** in Malaysia. This includes the inefficiency, lack of transparency, inconsistent communication, and administrative burden associated with dealing with multiple agencies such as the Expatriate Services Division (ESD), Malaysian Development Corporation (MDEC), and Ministry of Human Resources (MOHR). The way these regulatory processes are structured and managed directly influences the outcomes for companies like Lingkail Sdn Bhd.

Dependent Variable:
The **dependent variable** is the **firm's performance** in the context of hiring skilled expatriate talent. This is evidenced by the impact on Lingkail Sdn Bhd's productivity, operational costs, project deadlines, and overall competitiveness in the software development industry. The challenges and delays encountered in the regulatory process directly affect the company's ability to innovate, grow, and maintain its competitive edge in the market.

This qualitative study highlights how the bureaucratic challenges of expatriate hiring processes can hinder a company's ability to effectively recruit skilled professionals, ultimately affecting its performance, client satisfaction, and long-term growth in the competitive tech sector.

4.12.9 Qualitative Analysis for Case Study 9 (CS9)
Based on the qualitative study of regulatory delays and their impact on supply chains experienced by Beye, the independent and dependent variables can be identified as follows:

Independent Variable:
The **independent variable** in this study is the **regulatory framework and delays** affecting aluminium imports in Malaysia. This includes factors like the slow pace of regulatory updates by the Standards and Industrial Research Institute of Malaysia (SIRIM), the rigidity of the approval processes, and the lack of alignment between local regulations and global market developments. These variables impact the ability of companies like Beye to adapt to changes in the market for raw materials.

Dependent Variable:

The **dependent variable** is the **firm performance and supply chain efficiency** of Beye in the aluminium trading sector. The regulatory delays led to significant disruptions in Beye's supply chain, causing financial losses, increased storage costs, delayed deliveries, customer dissatisfaction, and a weakened market position. These issues resulted in operational inefficiencies, reduced profitability, and potential erosion of the company's competitive edge and market reputation.

This analysis underscores the importance of agile and adaptive regulatory practices to minimize supply chain disruptions and protect the performance of firms operating in dynamic sectors like the electronics industry, highlighting the need for regulatory flexibility and proactive risk management strategies.

4.12.10 Qualitative Analysis for Case Study 10 (CS10)

Based on the qualitative study of violations of **Responsible Business Alliance (RBA)** standards in Malaysia's electronics industry, the independent and dependent variables can be identified as follows:

Independent Variable:

The **independent variable** in this study is the **compliance with RBA standards** in the treatment of workers within Malaysia's electronics supply chain. This includes factors such as labour practices, recruitment fees, passport retention, forced overtime, wage withholding, unsafe working conditions, and overall adherence to ethical standards set by the RBA Code of Conduct.

Dependent Variable:

The **dependent variable** is the **firm performance and supply chain stability** of companies like ATA IMS and First Solar. Violations of RBA standards lead to significant consequences, including reputational damage, decreased investor confidence, loss of business partnerships, stock devaluation, increased operational costs due to corrective actions, and disruptions in supply chains. These factors directly impact profitability, market competitiveness, and firms' ability to sustain operations in compliance-driven markets such as the EU.

This analysis highlights the critical impact that adherence to labour standards has on firm performance, emphasizing the need for stringent regulatory compliance and proactive measures to maintain ethical labour practices in Malaysia's electronics industry to protect business continuity and global competitiveness.

4.12.11 Case Study Insight Synthesis

From the case studies (1 through 10), we extract recurring themes and link them to firm outcomes:

A. **Innovative Performance (IP) Factors:** Several cases (especially 1, 2, 3) highlighted the importance of *technology adoption* and *R&D collaboration*. Firms that proactively engaged in R&D (Case 1's GaN program participant, Case 3's smart manufacturer) saw improvements in efficiency, product capabilities, and in some cases market opportunities (the GaN initiative attracted MNC interest). Conversely, firms that did not invest in new technologies or product development were either absent from our case highlights (perhaps tellingly) or mentioned as the struggling backdrop to those that did. A pattern is that innovation often required a trigger or support (CREST's program, Industry4WRD incentives). This suggests that **without supportive context**, many

firms might not innovate, which in turn would stagnate their performance (flat sales, loss of contracts, etc.).

IP Qualitative finding: Firms engaging in higher innovative activities tend to have better performance prospects (growth, new contracts) *if* they successfully overcome initial barriers (knowledge or cost barriers) to innovate. The cases qualitatively support Hypothesis H1 (IP → FP) – e.g., the smart manufacturing adopter (high IP) improved its yield and became more profitable, while the GaN effort opened potential new markets.

B. **Talent Management (TM) Factors:** Virtually all cases touched on talent in some form, confirming it as a cross-cutting factor. The talent gap and skill issues (Cases 4-7) directly affect firm performance by limiting what projects firms can undertake or how efficiently they operate. For example, in Case 5, a company wanted to expand into a new design service but couldn't hire enough qualified engineers – a clear instance where lack of talent constrained business growth (performance). In Case 3, the firm's ability to implement smart manufacturing hinged on having engineers who could work with robotics and data analytics; they succeeded partly because they had invested in training their staff who then delivered performance improvements. Brain drain (Case 7) often meant local firms lost experienced staff to competitors abroad, weakening their performance capabilities until replacements were trained.

TM Qualitative finding: A strong talent base (skills, experience, retention) is associated with better firm performance – companies with effective talent management could innovate faster and adapt to challenges, whereas those facing talent shortages experienced operational bottlenecks and missed opportunities. This aligns with Hypothesis H2 (TM → FP); the cases give narrative evidence of how workforce quality and stability enable or hinder firm success.

C. **Regulatory Environment (RE) Factors:** Cases 8-10 depicted scenarios where regulatory issues directly impacted firm operations and outcomes. Case 9's supply chain delay clearly hurt performance (financial loss, production downtime) – a negative regulatory impact. Case 10 showed that regulatory inaction (on labour standards) could have resulted in losing business if not corrected. Indirectly, performance would suffer without meeting those standards. On the positive side, Case 8's reference to improved processes (single window) shows that *when* the regulatory environment was improved, it reduced time and effort for the firm, contributing to smoother expansion that an enabling effect on performance.

RE Qualitative finding: A supportive regulatory environment (efficient processes, clear standards in line with global norms) facilitates firm performance by reducing compliance costs and uncertainties, whereas a cumbersome or misaligned regulatory environment hinders performance through delays, additional costs, or barriers to market entry. This provides qualitative backing for Hypothesis H3 (RE → FP), as we saw instances where improving RE helped firms (thus likely improving performance) and where poor RE hurt firms' performance.

In qualitative analysis summary, the determinants of firm performance in Malaysia's electronics sector: innovation capability, talent quality, and regulatory context, are all crucial and act in concert. The case studies affirm that addressing weaknesses in these areas is likely to yield better firm-level outcomes. Firms that found ways to innovate (either through internal effort or external collaboration) tended to thrive or at least survive better in the competitive environment. Those that secured and nurtured the right talent could execute strategies

effectively and adapt to changes, directly boosting performance metrics. And firms benefiting from a benign regulatory environment (or conversely suffering from a poor one) saw corresponding effects on their efficiency and market access.

Indeed, studies like Artz et al. (2010) found R&D and innovation correlate with firm performance, and others like Barney (1991) under RBV would support our view that internal resources (talent, tech) drive performance. Also, issues of regulation and performance are echoed by works like Djankov et al. (2006) who linked heavy regulation to slower growth. So our qualitative conclusions are in line with established knowledge, adding context-specific insight.

This qualitative analysis sets the stage for the next chapter by confirming that our focus areas (IP, TM, RE) indeed matter greatly for firm performance. It provides confidence that the policy interventions we propose should target these areas. The insights also hint at priority areas: for instance, talent issues appear extremely pervasive, virtually every case pointed to it that suggesting perhaps talent management requires urgent and multi-faceted policy attention. Innovation and regulation factors also show up as significant and somewhat easier to address through structured programs (since talent is a longer-term societal issue, while innovation funding or regulatory tweaks can have quicker impacts).

4.13 Synthesized Independent and Dependent Variables

This section synthesizes how we conceptualize the independent variables (IP, TM, RE) and the dependent variable (firm performance, FP) for the upcoming quantitative analysis in Chapter 6. It defines how each is operationalized based on the qualitative findings and literature, serving as a link between qualitative and quantitative phases. Based on the qualitative studies across multiple areas in Malaysia's technology, engineering, and manufacturing sectors, here is a synthesized summary of the independent and dependent variables identified in each case study in Table 4.13.1.

Table 4.13.1: Relationship Between Independent Variables and Firm Performance in Malaysia's Technology and Engineering Industries

Case Study Topic	Independent Variables	Dependent Variables
CS1: Gallium Nitride (GaN) Technology Adoption	Factors influencing GaN **technology integration**, including **research advancements**, 300 mm GaN power wafers, **strategic partnerships**, **government support**, and **manufacturing challenges**.	Firm performance in terms of **product efficiency**, **global competitiveness**, **revenue opportunities**, and risks like **operational inefficiencies** and **supply chain vulnerabilities**.
CS2: AI and Quantum Computing	**Adoption** and **integration** of AI and quantum computing, including **infrastructure**, **cost considerations**, **talent availability**, **technological**	Firm performance related to **operational efficiency**, **cost reduction**, **productivity**, and **competitiveness**.

	advancements, and market demands.	
CS3: Smart Manufacturing in Malaysia	**Adoption** of smart manufacturing technologies like AI-driven maintenance, automation, machine learning, data analytics, and **government support** for workforce development.	Firm performance in **manufacturing efficiency**, **resource optimization**, **productivity**, **cost reduction**, and **innovation capacity**.
CS4: Talent Development Challenges in Electronics	**Availability and development of talent** in the E&E industry, involving **skilled workforce supply**, **educational infrastructure**, and **industry-academia collaboration**.	Firm performance in areas like **revenue**, **project timelines**, **operational costs**, **R&D opportunities**, and **advanced technology adoption**.
CS5: Talent Gap in E&E and Mechanical Engineering	**Supply of E&E and Mechanical Engineering graduates**, influenced by STEM **enrolment trends**, **industry-academia disconnect**, **practical training gaps**, and **competitive salaries**.	Firm performance concerning **project delays**, **innovation capacity**, **recruitment costs**, and **competitiveness in the technology sector**.
CS6: Declining Interest in Engineering	Factors affecting interest in engineering careers, including **education system flaws**, **societal perceptions**, **career concerns**, and **work-life balance** issues.	Firm performance impacts on **recruitment costs**, **innovation, productivity**, and **competitiveness**.
CS7: Impact of Brain Drain	Factors driving brain drain, such as **salary disparities**, **limited career opportunities**, **social inequalities**, and **proximity to better job markets abroad**.	Firm performance and **talent availability in engineering**, **affecting project timelines**, **innovation**, **competitiveness**, and **economic growth**.
CS8: Regulatory Hurdles in Hiring Expatriates	**Regulatory processes** for expatriate hiring, including **inefficiencies**, **lack of transparency**, and **administrative burdens** involving multiple agencies.	Firm performance in **hiring skilled talent**, **productivity**, **operational costs**, **project deadlines**, and **competitive positioning**.

CS9: Regulatory Delays in Supply Chains	**Regulatory framework and delays** affecting material imports, including SIRIM's **slow updates** and **rigid approval processes**.	Firm performance and **supply chain efficiency**, impacted by **financial losses**, **customer dissatisfaction**, and **market competitiveness**.
CS10: RBA Standards Violations in Electronics	**Compliance** with RBA standards, involving **labour practices**, **recruitment fees**, **unsafe conditions**, and **adherence to ethical codes**.	Firm performance and **supply chain stability**, including **reputational damage**, **investor confidence**, **operational costs**, and **market competitiveness**.

The independent variables across these studies generally focus on factors like technological adoption, talent availability, regulatory processes, and compliance with ethical standards. The dependent variables consistently revolve around firm performance metrics, including efficiency, innovation, profitability, market competitiveness, supply chain stability, and the ability to attract and retain talent. These relationships highlight the critical role that external factors, whether technological, regulatory, or labour-related, play in shaping the operational and competitive outcomes of firms in Malaysia's high-tech sectors.

Based on the qualitative analysis from the 10 case studies, the independent variables (IVs) and dependent variables (DVs) have been synthesized into a structured research framework. The case studies, which focus on firm performance, have identified three key independent variables that significantly influence it: Innovative Performance, Talent Management, and Regulatory Environment (See Figure 4.13.1). Below is a summary of these independent variables, including their primary influencing factors, along with the dependent variable, which is represented in terms of firm performance.

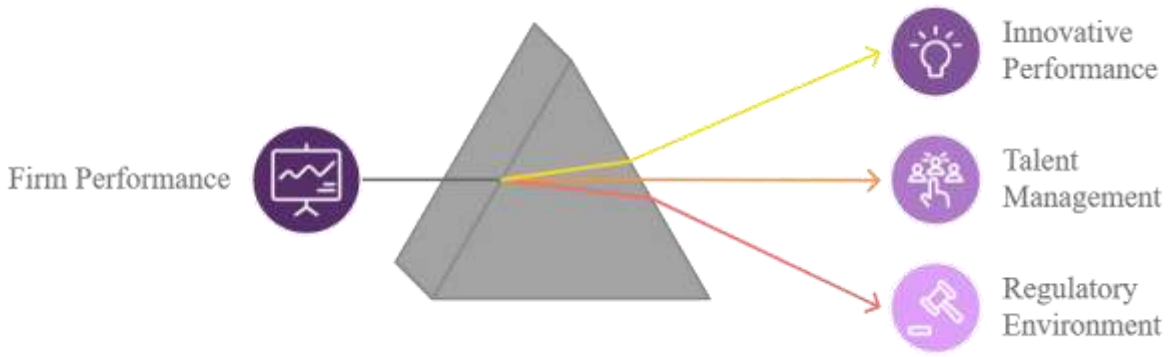


Figure 4.13.1: Disintegrate the Firm Performance into three major factors

Independent Variables (IVs):

1. **Innovative Performance (IV1 - IP):** This variable represents a firm's capacity and output in innovation. Based on our study, it includes aspects such as R&D intensity (expenditure, projects), product/process innovation count, and adoption of advanced

technologies. It captures both input (effort, resources devoted to innovation) and output (number of new products, patents, improvements implemented). From the cases, relevant indicators included whether a firm participated in R&D collaborations, the extent of new technology usage, etc. For quantitative measurement, we will likely use metrics like R&D spending as a percentage of sales, number of innovations introduced in the last 3 years, or a composite innovation index.

- Factors such as technology adoption, integration of AI and quantum computing[Case Study 2 (CS2)], smart manufacturing[CS3], and advancements in Gallium Nitride (GaN) technology[CS1].
- Includes technological innovations[CS1,CS2], R&D capabilities, infrastructure development[CS2], and market conditions[CS2,CS7].
- Relies on the organization's ability to innovate, implement new technology, and leverage technological advancements to enhance operations and productivity.

2. **Talent Management (IV2 - TM):** This variable encompasses the availability, quality, and management of human capital within the firm. It includes indicators such as employee skill levels (education, training hours), talent retention rates (turnover), and the firm's ability to fill key positions with qualified individuals. It also touches on HR practices like performance incentives, career development opportunities, etc. Our qualitative work showed talent is a multi-dimensional construct (quantity and quality). For quantification, possible measures are average years of employee experience, percentage of employees with relevant degrees or certifications, training expenditure per employee, turnover rate, and perhaps a rating of skill adequacy relative to company needs (possibly collected via survey).
   - Focuses on the availability, development, and management of skilled talent in sectors like engineering, electronics, and mechanical industries[CS2,CS4,CS5,CS6].
   - Key factors include workforce development initiatives, industry-academia collaborations[CS5], government support for talent development[CS?], supply of skilled graduates[CS4,CS5,CS6,CS7], and the management of brain drain[CS7].
   - Addresses issues related to skill gaps[CS5], talent shortages[CS5,CS7], and the effectiveness of attracting and retaining local talent to maintain a competitive workforce[CS7].
3. **Regulatory Environment (IV3 - RE):** This variable captures the external regulatory context affecting the firm. It can be measured by the perceived ease of doing business, regulatory compliance burden, or the degree of government support perceived. It may include specific indicators like the time taken to obtain approvals, the number of regulatory issues faced in a year, or a satisfaction score with government policies. Additionally, membership in initiatives like free trade zones or usage of government incentives might indicate a supportive environment. In our survey, we might operationalize RE via Likert-scale items on whether firms find regulations and government procedures supportive or hindering, and whether they engage with available government support programs.
   - Involves the impact of regulations, standards, and bureaucratic processes on firm operations, especially in hiring expatriates[CS8] and supply chain management[CS9].
   - Considers factors like inefficiencies in regulatory frameworks[CS8,CS9], compliance with Responsible Business Alliance (RBA) standards[CS10], government support, and transparency in dealing with multiple regulatory bodies.
   - The focus is on how regulations either enable or hinder business growth, supply chain efficiency[CS9], and market adaptability.

Dependent Variable (DV): Firm Performance (FP): The dependent variable, firm performance, in our context is a **multi-dimensional construct**. It includes *financial performance* (sales growth, profitability, ROI), *operational performance* (productivity, defect rates, delivery times), and *innovative output* (as a performance outcome, e.g., number of new products launched, market share in new products). For comprehensive analysis, especially under the lens of TFSC which values forward-looking performance, we might also include *capability development* as part of performance (like capability to enter new markets or segments). However, primarily we will focus on conventional performance metrics that can be objectively reported or rated by respondents: revenue growth rate over the last 3 years, profit margin relative to competitors, export growth (if applicable), etc. We may also use a subjective overall performance rating (as is common in surveys, asking managers to rate their firm's performance relative to objectives or competitors). By combining multiple indicators, we aim to get a holistic view of firm performance.

- Firm performance is influenced by the above variables and is evaluated in terms of:
    - **Operational Efficiency**[CS2,CS3]: How well firms manage their operations, including cost reductions, productivity enhancements, and resource optimization.
    - **Innovation Capacity**[CS1,CS2,CS3]: The ability to adopt, integrate, and capitalize on new technologies to create innovative products or services.
    - **Market Competitiveness**: Firms' competitiveness in the global market[CS1,CS2,CS6,CS7,CS8,CS9,CS10], which is linked to their technological advancements[CS1,CS2,CS3], skilled workforce[CS2], and adherence to regulations[CS10].
    - **Talent Retention and Development**: The availability of skilled professionals, reduced reliance on expatriates[CS7], and effective workforce management.
    - **Supply Chain Stability**: The impact of regulatory delays and disruptions on supply chain operations[CS8,CS9], which directly affects profitability and market positioning[CS8].
    - **Reputation and Compliance**[CS10]: The importance of maintaining ethical labour practices, compliance with international standards, and mitigating reputational risks.

Table 4.13.2 Proposed Quantitative Framework

Independence Variable	Dependence Variable
Innovative Performance (0): Technology Integration[CS1,CS2]; Research Advancements[CS1]; Strategic Partnerships[CS1]; Government Support[CS1,CS3]; Manufacturing Challenges[CS1]; Technology Adoption[CS2,CS3,CS4]; Technological Advancement[CS2]; Cost Considerations[CS2]	**Firm Performance** (0): Product Efficiency[CS1], Global Competitiveness[CS1,CS2,CS6,CS8], Revenue Opportunities[CS1], Operational Efficiency[CS3]; Resource Optimization[CS3]; Productivity[CS3,CS6]; Manufacturing Efficiency[CS3]; Cost Reduction[CS3]; Innovation Capacity[CS3,CS5CS6]; Revenue[CS4]; Project Timelines[CS4,CS8]; Operational Costs[CS4,CS8,CS10]; R&D Opportunities[CS4]; Competitiveness in the Technology Sector[CS5]; Hiring Skilled Talent[CS8]; Supply Chain Efficiency[CS9]; Market Competitiveness[CS9,CS10]; Supply Chain
Talent Management (0): Talent Availability[CS2,CS4]; Skilled Workforce Supply[CS4]; Educational Infrastructure[CS4]; Industry-Academia Collaboration[CS4]; Supply of E&E And	

<table>
<tr><td>Mechanical Engineering Graduates[CS5]; STEM Enrolment Trends[CS5]; Competitive Salaries[CS5]; Future Talent Pipeline[CS6]

(–): Industry-Academia Disconnect[CS5]; Practical Training Gap[CS5]; Education System Flaws[CS6]; Societal Perceptions[CS6]; Career Concerns[CS6]</td><td rowspan="2">Stability[CS10]; Reputational Damage[CS10]

(–): Operational Inefficiencies[CS1]; Supply Chain Vulnerabilities[CS1]; Project Delays[CS5,CS8]; Recruitment Costs[CS5,CS6]; Financial Losses[CS9]; Customer Dissatisfaction[CS9]; Investor Confidence[CS10]</td></tr>
<tr><td><u>Regulatory Environment</u>

(+): Adherence to Ethical Codes[CS10]

(0): Compliance[CS10]

(–): Regulatory Processes Inefficiencies[CS8]; Lack of Transparency[CS8]; Administrative Burdens[CS8]; Regulatory Framework Slow Update[CS9]; Rigid Approval Processes[CS9]</td></tr>
</table>

Definition of Variables

Innovative Performance (IP)
Innovative performance refers to a company's ability to develop, implement, and bring new products, services, processes, or ideas to the market that enhance its competitive position. This includes a firm's effectiveness in research and development (R&D), creativity, and the capability to transform ideas into commercially viable solutions that drive growth and market differentiation. Government support plays a crucial role in this by providing funding, creating policies that foster innovation, and facilitating partnerships between businesses and research institutions. This construct measures how well companies leverage such support to introduce new products, accelerate time-to-market, apply innovative methods to problem-solving, adapt production methods quickly, and adopt new management strategies.

Talent Management (TM)
Talent management is the systematic process of attracting, developing, retaining, and optimizing a workforce to achieve strategic business goals. This includes identifying the right talent, providing ongoing training and career development, and ensuring that employees in key roles are engaged and contributing to the organization's success. The government's role in talent management is critical, particularly through educational initiatives, policies for skill development, and programs aimed at talent retention, such as subsidies for training or incentives for high-demand fields. This construct evaluates the effectiveness of talent acquisition, retention, and development practices, and how government interventions support businesses in building a skilled and sustainable workforce.

Regulatory Environment (RE)
The regulatory environment consists of the laws, regulations, policies, and compliance frameworks that govern business operations in a specific industry or region. These regulations impact areas such as market entry, innovation efforts, and adherence to safety and ethical standards. The government's role is fundamental in creating a regulatory environment that is transparent, consistent, and supportive of business growth while ensuring compliance with ethical and safety standards. This construct assesses how these laws and policies are perceived in terms of their effectiveness and clarity, and how government regulations either enable or constrain business innovation and competitiveness.

Firm Performance (PE)
Firm performance measures a company's overall success in achieving its business objectives, including both financial and non-financial outcomes. Financial metrics might include profitability, revenue growth, return on investment, and market share, while non-financial indicators include customer satisfaction, innovation capacity, and operational efficiency. The government's role influences firm performance by providing financial incentives, fostering a supportive regulatory environment, and investing in infrastructure that enhances business operations. This construct evaluates a company's performance in collaboration with the government, focusing on metrics such as sales revenue, profitability, return on assets, customer satisfaction, labour productivity, and market share growth.

Synthesized Research Framework Overview:
The research framework highlights the relationship between the independent variables (IVs) and the dependent variable (DV) in the context of **firm performance**, using the **Resource-Based View (RBV)** as the underpinning theory. The RBV suggests that a firm's resources and

capabilities, including innovation, talent, and regulatory adaptability, are critical in achieving a sustainable competitive advantage.

- **IV1: Innovative Performance** → Impacts the firm's ability to stay competitive, innovate, and integrate new technologies, driving growth and market differentiation.
- **IV2: Talent Management** → Influences workforce development, skill availability, and the firm's capacity for innovation. Talent is a key resource in the RBV framework, enabling firms to leverage human capital for strategic advantage.
- **IV3: Regulatory Environment** → Affects the firm's operational processes, compliance, supply chain efficiency, and market adaptability. Effective management of external regulatory pressures allows the firm to reduce risks and maintain operational fluidity.

These independent variables collectively influence the **dependent variable: Firm Performance**, which is evaluated through key metrics such as productivity, innovation output, cost efficiency, competitiveness, and compliance with industry standards.

The **quantitative research** approach will involve designing constructs and items based on this framework in the Figure 4.13.2, developing measurable indicators that capture the essence of each construct (both IVs and DV). This allows the constructs to be tested and analyzed for their contribution to the firm's overall performance, in line with RBV theory, where firm-specific resources and capabilities determine competitive advantage.

In summary, this section has identified and defined the independent and dependent variables for our study, informed by both qualitative evidence and theoretical grounding. With this in place, we are prepared to design the quantitative analysis (survey and modeling) to empirically test the relationships in the next phase of the research.

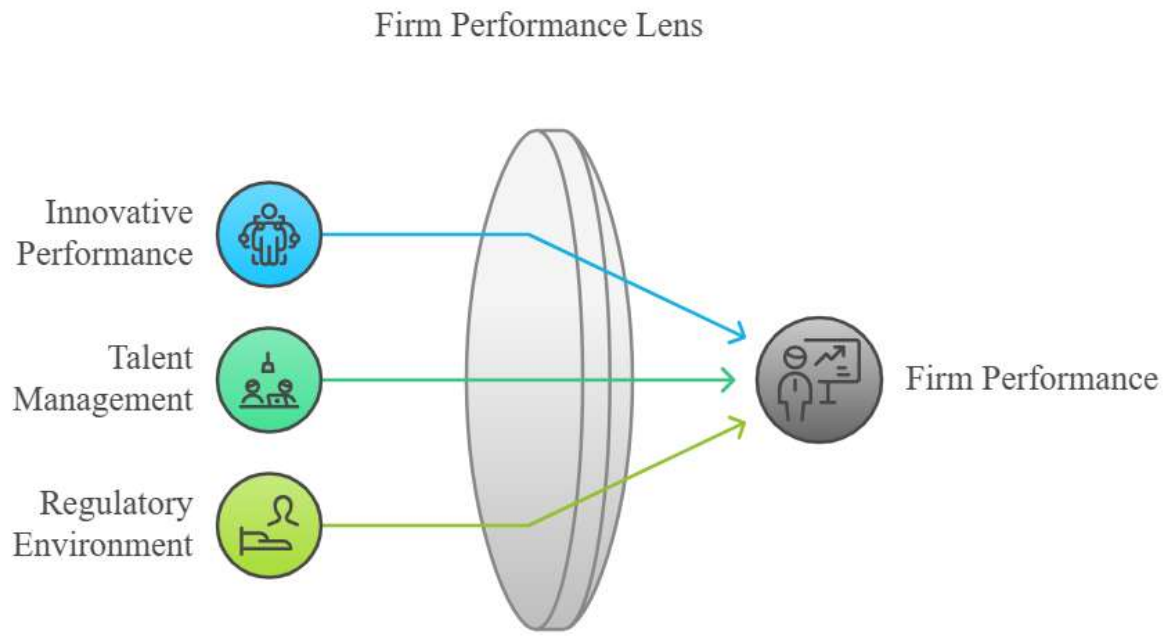


Figure 4.13.2: Conceptual Framework Linking Government Interventions and Firm Performance

4.14 Chapter Conclusion

Chapter 4 presented an in-depth qualitative exploration of the challenges and opportunities within Malaysia's electronics industry via multiple case studies. Through these cases, we identified how **innovation, talent, and regulatory factors** manifest in real scenarios and how they impact firm outcomes. The qualitative analysis distilled common factors influencing firm performance and reaffirmed the importance of strengthening IP, TM, and RE to achieve better results. We also synthesized these insights into clearly defined variables and a conceptual framework that bridges our qualitative and quantitative analyses.

This chapter has explored the multifaceted challenges and opportunities present within Malaysia's electronics industry, particularly focusing on the critical aspects of innovative performance, talent management, and regulatory environment. Through an extensive qualitative analysis of various case studies, the chapter highlighted the intricate dynamics that influence firm performance in the context of Malaysia's evolving technological landscape.

The adoption of advanced technologies such as Gallium Nitride (GaN), AI, quantum computing, and smart manufacturing has proven to be essential for driving innovation and enhancing operational efficiency in the electronics sector. However, these advancements also require robust talent management strategies and a supportive regulatory environment to foster sustainable growth and competitiveness.

Role of the Government

The government's role is paramount in addressing the challenges identified in the qualitative analysis. It plays a crucial part in fostering an ecosystem that supports innovation, talent development, and regulatory reforms. Specifically, in Figure 4.14.1 summarises the following actions by the government can help mitigate the identified challenges and enhance the competitiveness of Malaysia's electronics sector:

1. **Promoting Innovation and R&D**: The government should continue to invest in R&D initiatives, supporting collaborative projects between industry players, academic institutions, and research organizations. By providing funding, incentives, and infrastructure for innovation, Malaysia can accelerate the adoption of cutting-edge technologies such as GaN, AI, and quantum computing.
2. **Talent Development and Retention**: Addressing the talent gap is a critical issue that requires government intervention. By investing in educational reforms, promoting STEM education, and providing scholarships and incentives for students in engineering and technical fields, the government can ensure a steady pipeline of skilled professionals. Additionally, creating favourable conditions for retaining local talent and reducing the brain drain phenomenon is essential to strengthen the workforce in Malaysia's electronics industry.
3. **Regulatory Reforms**: Streamlining regulatory processes, enhancing transparency, and improving inter-agency coordination are vital steps to make Malaysia's business environment more conducive to attracting foreign investments and skilled expatriates. A centralized platform for expatriate hiring, improved supply chain flexibility, and a focus on compliance with global standards like the RBA can enhance the industry's operational efficiency and international competitiveness.
4. **Building a Resilient Ecosystem**: The government should foster a resilient industrial ecosystem by encouraging partnerships between local companies and international players. This will facilitate knowledge transfer, skill development, and access to new markets, strengthening Malaysia's position as a global hub for high-value technological manufacturing.

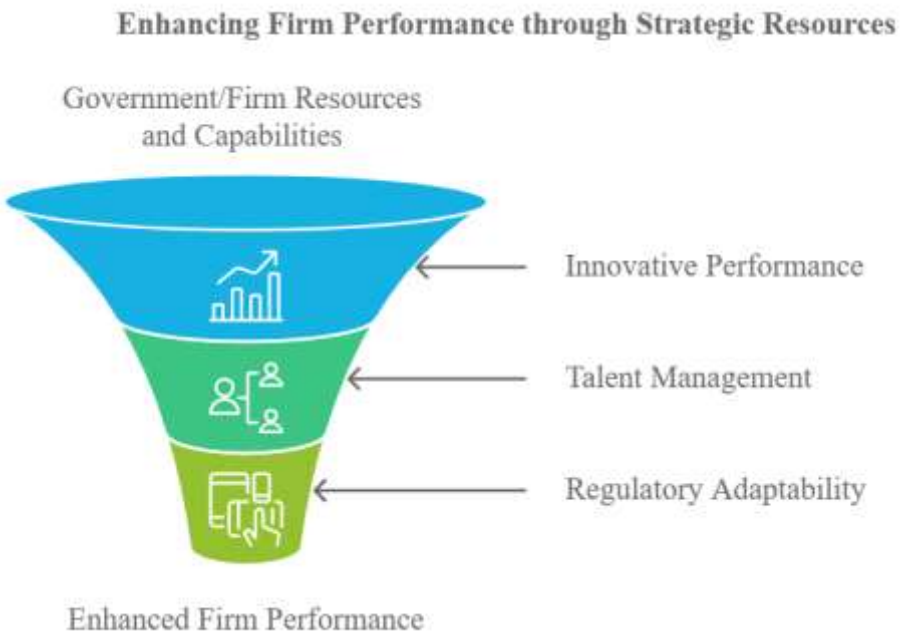


Figure 4.14.1: Cooperation between Firm and Government in enhancing the Firm Performance

Need for Quantitative Analysis

While the qualitative analysis in this chapter provides valuable insights into the key factors influencing firm performance in Malaysia's electronics sector, it is essential to conduct a quantitative analysis to validate and substantiate these findings with the governmental influences. Quantitative analysis will offer empirical evidence to support the claims made in the research framework by statistically examining the relationships between the independent variables (innovative performance, talent management, and regulatory environment) and the dependent variable (firm performance). Thus, the researchers will operationalize these variables by constructing the governmental influences into the study, as shown in Figure 4.14.2.

By employing techniques such as regression analysis and other relevant statistical methods, future studies can quantify the impact of these factors, providing actionable data to guide policy decisions and strategic business interventions.

Final Thoughts

In conclusion, the case studies underscore that while Malaysian electronics firms face significant hurdles, there are clear pathways and examples of overcoming them. Innovative endeavours, when supported by skilled talent and a conducive policy environment, can lead to superior performance. Conversely, lapses in any of these areas can impede progress. This duality of challenges and opportunities provides a strong rationale for **targeted government interventions**.

Therefore, as we move into **Chapter 5**, we shift focus to actionable solutions. Building on the understanding gained, Chapter 5 will outline specific recommendations for government and stakeholders to enhance innovative performance, talent management, and the regulatory

environment in Malaysia's electronics sector. These recommendations will be formulated with reference to best practices (including those gleaned from other Asian economies and global benchmarks) and are aimed at translating the opportunities identified into concrete strategies. Essentially, Chapter 5 serves as the prescriptive culmination of our qualitative findings by providing a roadmap for addressing the issues diagnosed.



Figure 4.14.2: Innovative Performance, Talent Management and Regulatory approach the Firm Performance

5. Actionable Steps for the Government to Implement Recommendations

Penang's potential to evolve into a global electronics hub can be significantly enhanced through deliberate and strategic government interventions. Drawing inspiration from Shenzhen, China, once a small fishing village that transformed into a global technology hub - "Silicon Valley of China", through targeted government policies. Penang can similarly establish itself as a critical player in the global electronics industry. In 1980, Shenzhen was designated as a Special Economic Zone (SEZ - 深圳经济特区), attracting domestic and international tech companies by offering tax incentives, regulatory easing, and substantial infrastructure investments. These government-led efforts fostered an environment of industrial growth and innovation, propelling Shenzhen to achieve a GDP of over $453 billion (Yuan, 2024; Statista, 2023b; Ng, 2003). Comparatively, Penang's GDP stood at $28 billion in 2022 (Statista, 2023a), a stark contrast that underscores the potential impact of well-executed policy measures.

In addition to Shenzhen, the transformation of Hsinchu, Taiwan, offers another exemplary model for Penang. Hsinchu Science Park (HSP - 新竹科学园区), established in 1980, played a pivotal role in making Taiwan a global leader in semiconductor manufacturing. The Taiwanese government's vision to focus on high-tech industries was supported by strategic investments in infrastructure, education, and research and development (R&D). Taiwan Semiconductor Manufacturing Company (TSMC), headquartered in Hsinchu, emerged as a global giant due to this ecosystem. The synergy between academia, industry, and government in Hsinchu ensured a steady pipeline of talent, world-class research, and innovation-driven policies. Today, Hsinchu Science Park contributes over $80 billion annually to Taiwan's economy, solidifying its reputation as the "Silicon Valley of Asia" (Hu, 2011; Lee & Yang, 2000; Chen, 2008).

By combining the lessons of Shenzhen's SEZ and Hsinchu's integrated science and technology ecosystem, Penang can chart a transformative path that leverages its unique advantages. Building on its existing strengths and adopting tailored strategies to enhance Innovative Performance (IP), Talent Management (TM), and the Regulatory Environment (RE) will be crucial. Recent developments such as the RM50 million allocation for Penang's Silicon Design Initiative and the launch of Malaysia's Semiconductor IC Design Park further position Penang for accelerated growth in the electronics sector (Malay Mail, 2024b; SIDEC, 2024). These initiatives are expected to serve as a catalyst for the industry's advancement by fostering innovation and attracting global investments.

5.1 Enhancing Innovative Performance (IP)

The foundation for innovation in Penang's electronics sector lies in creating a robust ecosystem that supports research and development (R&D), fosters collaboration between academia and industry, and cultivates a culture of creativity and risk-taking. To boost innovation in the electronics sector, the government should act as both a facilitator and a funder where appropriate. Key recommendations include:

5.1.1 Facilitating Access to R&D Funding and Incentives

Historically, some Malaysian SMEs complain that applying for government grants is cumbersome and they are unsure of the success rate. Streamlining applications and providing advisory support can improve uptake. Also, ensuring transparency in award decisions will maintain ethical standards and trust in these programs.

To encourage innovation, Prime Minister Anwar Ibrahim recently announced a RM50 million allocation for the Penang Silicon Design Initiative, a strategic move aimed at bolstering the state's position as a hub for chip design and semiconductor development (Malay Mail, 2024b).

This initiative will provide targeted funding and resources for research and innovation, enabling both large corporations and small and medium enterprises (SMEs) to enhance their technological capabilities.

Collaborating with federal agencies such as the Malaysian Investment Development Authority (MIDA) and the Ministry of International Trade and Industry (MITI) can further expand funding opportunities. Aligning state-level incentives with national strategies ensures that firms in Penang benefit from a comprehensive support system that integrates technological resources and financial assistance.

The government should expand grant programs (like those under MOSTI or MIDA) focusing on electronics and emerging technologies (e.g., compound semiconductors, AI hardware, IoT devices). Specifically, a dedicated Electronics Industry Innovation Fund could be established, providing matching grants or seed funding for projects that local firms undertake, especially those involving collaboration with universities or foreign tech partners. This addresses the limited R&D investment issue by sharing risk and cost.

Additionally, enhance tax incentives for R&D: for instance, extend the duration and scope of the existing double tax deduction for R&D expenditure, and make the application process more user-friendly for SMEs. An example to emulate is Singapore's approach under the *Research Incentive Scheme for Companies* (RISC) and large tax deductions for R&D spending which the policies credited with raising private R&D significantly. Clear criteria and fast-track approval for these incentives will encourage more firms to utilize them. We also recommend introducing *innovation vouchers* for SMEs (a small grant that can be used to procure R&D services from research institutes or to hire technical consultants), which has been used effectively in countries like the Netherlands to stimulate SME innovation. By lowering the financial barrier, more companies, especially SMEs, will be able to experiment with new developments.

5.1.2 Promoting Industry-Academia Collaboration

Close monitoring and alignment of expectations is needed. In some past attempts, mismatches in timelines and goals caused collaborations to falter. Government can play a mediating role, perhaps via CREST or MIGHT, to keep projects on track. Ensuring IP rights are fairly allocated upfront in collaboratives agreements is also crucial to avoid disputes.

Bridging the gap between academic research and commercial applications is vital for driving innovation. The launch of Malaysia's Semiconductor IC Design Park in Penang exemplifies this synergy, as it integrates state-of-the-art facilities, training centers, and research labs. This park is designed to foster partnerships between universities, research institutions, and the electronics industry, providing a platform for collaborative research and innovation.

Federal bodies like the Ministry of Higher Education (MoHE) can align research funding with industry needs, ensuring that academic projects address real-world challenges faced by businesses in Penang. Programs such as the MoHE-Intel Elite Internship highlight the importance of such collaborations, providing students with practical experience and direct exposure to cutting-edge technologies in microelectronics and system-on-chip design.

The government should strengthen mechanisms that connect companies with research institutes and universities. One step is to expand collaborative platforms like CREST: increase its funding and scope so it can support more joint projects, across a wider range of topics (not just semiconductors but also emerging areas like quantum computing applications, advanced

materials, etc.). Creating Industry Innovation Consortia where multiple firms and universities work together on pre-competitive research can spread costs and benefits. For example, setting up a consortium on *Next-Generation Chip Design* in which participants co-develop IP that all can license would raise the innovation baseline. Models for this include Europe's CATRENE or the US Semiconductor Research Corporation's consortia.

To incentivize academia, adjust performance metrics for public research institutions to value industry collaboration (e.g., reward researchers for patents licensed or industry-funded projects, not just academic publications). The TalentCorp-Universities Collaborations referenced earlier should be leveraged to incorporate industry problem statements into academic R&D agendas. Another recommendation is to establish co-investment R&D centers in university campuses – for instance, a Center of Excellence in Electronics Packaging or in Automotive Electronics – with partial government funding, where companies can station their researchers alongside academics. South Korea's KAIST model within Daedeok Innopolis (where industry labs are adjacent to academic labs fostering daily interaction)could inspire this.

Furthermore, introduce an Innovation Sabbatical Program: encourage movement of people between industry and academia – e.g., allow industry engineers to spend 6–12 months in universities as adjunct researchers (with government covering part of their salary) and professors to take sabbaticals in industry labs. This cross-pollination builds mutual understanding and can lead to ongoing partnerships.

5.1.3 Cultivating an Innovation Culture

Promoting a culture of creativity, risk-taking, and continuous improvement within organizations is essential. Penang can initiate workshops, training sessions, and recognition programs to nurture an innovation-driven mindset among employees. Collaboration with federal campaigns that celebrate and reward innovation can amplify these efforts, reinforcing a shared commitment to excellence across the industry.

Beyond funding and partnerships, the government should help nurture an innovation mindset in the industry. We recommend launching national innovation recognition programs such as an annual *"Electronics Innovator Awards"* for companies (small, medium, large categories) that achieved notable innovations. Recognition, possibly by the Minister or Prime Minister, can motivate firms and also highlight role models. This could be accompanied by small grants or priority access to certain incentives for award winners.

Another strategy is integrating innovation metrics into government procurement. For example, when government-linked companies (GLCs) or public projects source electronics solutions, include criteria that favour innovative local content which this creates a market pull for innovation.

Additionally, promote a culture of patenting and intellectual property creation by setting up an IP support center specifically for electronics SMEs such as providing legal and technical assistance for filing patents or trademarks. Some firms refrain from innovating because they fear their ideas will be copied or they don't know how to protect them. Government can subsidize patent filing costs for first-time filers in the tech sector, as done in Japan and Korea for SMEs.

Furthermore, Singapore's experience shows that sustained government R&D investment (over 1% of GDP) was key to its tech growth; Malaysia currently spends around 1.0% (as of recent

years, per UNESCO data) – increasing this closer to 2% with private sector included, like South Korea's ~4%, would be transformative, but even targeted increases can help. We also align with the idea of foresight: by encouraging emerging tech (quantum, AI hardware) Malaysia is positioning for future relevance, not just current needs.

Finally, introduce innovation management training as part of capacity-building programs (perhaps under agencies like SME Corp or HRDF). Training workshops or bootcamps for C-level and R&D managers on topics like "Managing R&D and Commercialization", "Design Thinking for Hardware Startups", etc., can equip industry leaders with modern tools to foster innovation within their companies.

In summary, by addressing funding, collaboration, and culture, these recommendations tackle both the tangible and intangible aspects of innovative performance. The underlying principle is that government should reduce the risk and cost of innovation while amplifying the rewards and recognition for it.

5.2 Strategies for Improving Talent Management (TM)

To ensure a sustainable pipeline of skilled talent for the electronics industry, the government must intervene at multiple levels of the education-to-employment chain. Key strategies include:

5.2.1 Improving Government Policy on Talent Development

The electronics industry stands as a cornerstone of Malaysia's economy, significantly contributing to GDP and employment. As technological advancements redefine the global electronics landscape, Malaysia faces the critical task of ensuring its workforce remains skilled and adaptable to meet evolving industry demands. A strategic and coordinated effort by the government is essential to align education and training initiatives with the needs of the industry, creating a sustainable ecosystem for talent development.

Revamping Curricula

Update university and polytechnic curricula to better match industry needs. Incorporate more practical labs on semiconductor fabrication, PCB design, automation, etc., possibly through adjunct faculty from industry. Ensure that emerging topics (AI, data analytics, Industry 4.0) are integrated into engineering programs. The Ministry can mandate periodic curriculum reviews with industry input for public institutions (some private universities already implementing this to stay competitive).

Expanding University Seats and Scholarships in E&E

If demand outstrips supply for engineering education, allocate more slots to E&E and computer engineering in public universities. Provide scholarships or tuition waivers for students who choose these fields, especially for top students. For instance, the Public Service Department (JPA) could earmark a portion of its scholarships for critical fields like microelectronics design or nanotechnology, with bonds that they work in the country after graduating, potentially in government research centers or local industry.

Enhancing Technical and Vocational Education and Training (TVET)

Strengthen vocational colleges and polytechnics by upgrading equipment, so students train on the same machines used in industry and updating syllabi. Create specialized Electronics Technical Institutes focusing on skills like precision machining, PCB assembly, equipment maintenance, etc. Germany's apprenticeship model could be adapted: collaborate with major electronics firms in Malaysia to offer apprenticeship programs where students split time

between school and factory, learning hands-on. Government incentives like training grants or salary support can encourage companies to take on apprentices. This not only produces job-ready technicians but also often leads to hiring upon graduation, addressing the gap identified in Case 5.

Upskilling and Reskilling the Current Workforce
For immediate impact, utilize the HRD Corp (Human Resource Development Corporation, formerly HRDF) to finance targeted upskilling programs. For example, subsidize courses for existing engineers to learn new skills (AI programming, advanced sensor integration, etc.). Launch a "Semiconductor Upskilling Initiative" where engineers from declining sectors (like perhaps oil & gas or older manufacturing) can transition into electronics via short courses. According to the HRD Corp's own reports, continuous training yields higher productivity; thus making use of the training levy system to push more electronics-related courses can directly improve firm performance.

Learning from Singapore's MySkillsFuture: Creating Skilled Professionals to fill the Gap
A well-defined technology roadmap as in Figure 5.1 can serve as the foundation for this transformation. This roadmap should outline key technologies vital to Malaysia's competitiveness, such as 5G, IoT, and AI, while setting clear timelines for their development and adoption. In tandem, workforce planning must assess current and future labor demands, identify skill gaps, and implement targeted training programs. For example, addressing semiconductor manufacturing and advanced electronics design requires both upskilling the existing workforce and aligning educational institutions with industry needs. The goal is to create a steady pipeline of skilled professionals capable of driving Malaysia's electronics sector forward.

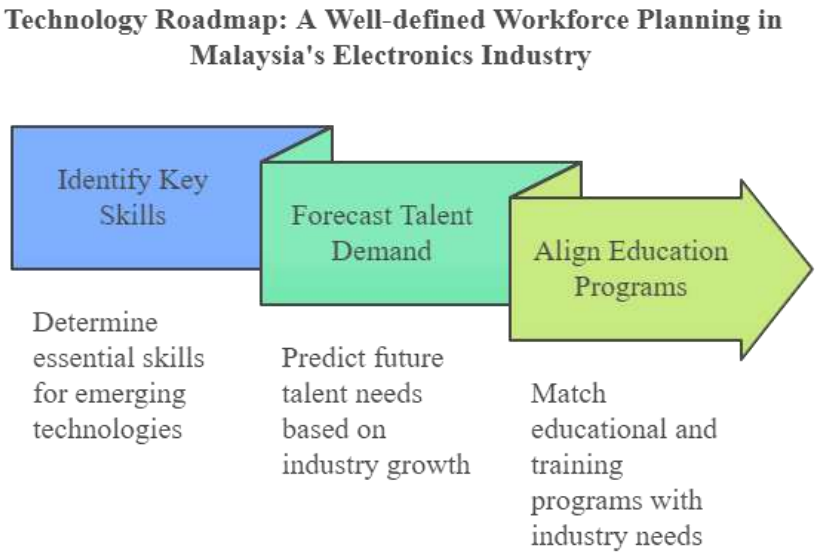


Figure 5.1: Workforce Planning in Malaysia's Electronics Sector

A relevant example is Singapore's MySkillsFuture initiative, a holistic national platform that supports lifelong learning and career planning. This initiative empowers individuals to take ownership of their professional development by offering personalized recommendations for courses, career insights, and skills development opportunities. For students, it provides resources to explore potential career paths and align their education with market demands. For working professionals, the platform serves as a tool to identify skill gaps, access industry-

relevant training, and navigate career transitions in response to evolving technological landscapes (MySkillsFuture, 2024). Malaysia can draw inspiration from this initiative to create a similar integrated framework that aligns workforce development with national priorities.

Fostering Innovation Through Proactive R&D Investments

Beyond strategic planning, proactive investment in R&D is pivotal. Collaboration between academia, industry, and government through public-private partnerships can drive innovation. Supporting startups and SMEs with funding and resources not only fosters a culture of creativity but also positions Malaysia as a creator, rather than just a consumer, of advanced technologies. Programs that promote technology adoption across industries can further ensure that Malaysian companies stay competitive in the global market.

A relevant example is Singapore's Agency for Science, Technology and Research (ASTAR), which plays a critical role in bridging research and industry by fostering innovation and technological advancement. ASTAR collaborates with public and private sectors to deliver cutting-edge research and development solutions tailored to industry needs. It supports startups and SMEs by offering funding, incubation programs, and access to state-of-the-art facilities, ensuring that these enterprises can innovate and scale effectively. Additionally, ASTAR's initiatives, such as its Industry Alignment Fund, drive partnerships that translate scientific research into commercially viable applications, reinforcing Singapore's position as a global hub for technology and innovation (ASTAR, 2024). Malaysia can emulate such a model to strengthen its R&D ecosystem and stimulate economic growth in high-tech industries.

Establishing a centralized talent development framework can streamline the roles and responsibilities of various stakeholders, including educational institutions, government bodies, and private enterprises. Strengthened partnerships with the private sector, such as designing industry-specific curricula, offering apprenticeships, and providing internship opportunities that ensure that education aligns with real-world applications. Additionally, continuous learning initiatives and data-driven decision-making processes can help the workforce adapt to technological advancements, ensuring Malaysia's position as a leader in electronics.

A notable example is the Malaysia Semiconductor IC Design Park, established through a unique collaboration under the Selangor Information Technology and Digital Economy Corporation (SIDEC). This initiative is designed to fuel growth in the semiconductor industry by providing state-of-the-art facilities and resources to nurture local talents, stimulate innovation, and attract global investments. By supporting the entire ecosystem from design and development to commercial applications, the Semiconductor IC Design Park serves as a critical enabler for Malaysia's ambitions to lead in the global semiconductor arena (SIDEC, 2024).

5.2.2 Ensuring a Sustainable Graduate Pipeline for the Electronics Industry

Malaysia's burgeoning electronics and mechanical engineering sectors require a robust pipeline of skilled graduates to sustain growth. The first step is to enhance STEM education, beginning at the primary and secondary levels. Early exposure to STEM concepts can spark interest, while well-trained educators and specialized schools can nurture talent. For instance, establishing STEM-focused programs for students with strong aptitude ensures that Malaysia develops a pool of individuals ready to tackle advanced engineering challenges.

Equally important is industry-academia collaboration. Universities must align their curricula with industry needs to produce graduates who are job-ready. This can be achieved through internships, cooperative education programs, and mentorship initiatives. For example,

collaborate to ensure university curricula align with industry needs and demands, provide ample opportunities for students to gain practical experience through internships and co-op programs, joint research projects between universities and companies not only foster innovation but also provide mentorship to students with hands-on experience in addressing industry-specific problems.

Financial support plays a critical role in encouraging more students to pursue STEM careers. Scholarships, whether merit- or need-based, can help attract top talent while reducing financial barriers. Industry-sponsored scholarships, in particular, can strengthen ties between companies and future graduates, creating a direct talent pipeline. Once in the workforce, initiatives that emphasize career growth, work-life balance, and continuous learning can help retain this talent within the country.

Raising public awareness is equally crucial. Campaigns that highlight the societal impact of STEM careers, coupled with showcasing successful Malaysian engineers as role models, can inspire the next generation to enter the field. By addressing these facets, Malaysia can build a sustainable talent pipeline that meets the growing needs of the electronics and engineering industries.

MoHE-Intel Elite Internship Program 2023

The MoHE-Intel Elite Internship Program is a 12-week collaboration between the Ministry of Higher Education (MoHE) and Intel Corporation. It offers undergraduate students a chance to join Intel's design and development team, providing hands-on experience with industry-standard electronic design tools and integrated circuit design. Benefits include competitive stipends, exposure to microelectronics tools, comprehensive training, and potential job offers for Graduate Trainees. The program aims to enhance graduate employability in the electronic and microelectronic fields by directly preparing them for industry roles. It involves training sessions, mentorship, and insights from senior engineers. Apart from that, Intel Internship Program also offers internships to students pursuing STEM degrees, providing practical experience and exposure to the industry.

Company Logo

intel.

Internship Details

Company name: **Intel Microelectronics (M) Sdn. Bhd.**

Address: **Intel PG15, 8, Medan Bayan Lepas, Bayan Lepas Industrial Park, 11900 Bayan Lepas, Pulau Pinang**

Contact no.: **07-2315141**

Industry Supervisor: **Mr. Khoo Ken Yi**

Department: **Programmable FPGA Engineering (PFE)**

Intern period: **24/7/2023 - 13/10/2020 (12 weeks)**

Company Information

Intel Corporation, commonly known as Intel, is a prominent American semiconductor manufacturer headquartered in Santa Clara, California, USA. The company's name is derived from "integrated electronics," and it stands as the world's largest semiconductor manufacturer, boasting major operations in the United States, Europe, and Asia. Established in 1968 by American engineers Gordon Moore and Robert Noyce, Intel has been significantly shaped by the leadership and vision of Andrew Grove. Initially, the company concentrated on SRAM and DRAM memory chips until the early 1980s, later pioneering the first commercial microprocessor chip in 1971. However, it was the rise of personal computers that solidified microprocessors as Intel's primary business focus.

About This Program

The MoHE-Intel Elite Internship Program is a 12-week collaboration between the Ministry of Higher Education (MoHE) and Intel Corporation. It offers undergraduate students a chance to join Intel's design and development team, providing hands-on experience with industry-standard electronic design tools and integrated circuit design. Benefits include competitive stipends, exposure to microelectronics tools, comprehensive training, and potential job offers for Graduate Trainees. The program aims to enhance graduate employability in the electronic and microelectronic fields by directly preparing them for industry roles. It involves training sessions, mentorship, and insights from senior engineers.

MoHE-Intel Certificate Ceremony



Figure 5.2: MoHE and Intel Elite Internship Program Launching Ceremony.



Figure 5.3: Launching ceremony of MoE-Intel Elite Internship programme graced by YB Minister Dr. Maszlee Malek at the Banquet Hall Ministry of Education, Putrajaya.

Figures 5.2 and 5.3 show the launching ceremony of MoE-Intel Elite Internship programme graced by YB Minister Dr. Maszlee Malek at the Banquet Hall Ministry of Education, Putrajaya and witnessed by the program stakeholders and Deans from partner universities. It is a new internship programme designed to increase the employability of Malaysian graduates by giving them industry-standard and real-world exposure in the field of microelectronics, silicon design and system-on-chip. From 250 over applications, 100 students were selected to join this program. The programme also includes attachment for 12 lecturers from the respective universities under an Intel Visiting Faculty Member programme and MOE AIExpert.

Bridging the Gap Between Industries and Universities: TalentCorp's Role in Bridging the Industry-Academia Gap

TalentCorp has been a key player in Malaysia's efforts to bridge the gap between industries and universities [Talent Corporation Malaysia. Industry – Academia Collaboration]. Their Industry-Academia Collaboration (IAC) program is a prime example of their initiatives to ensure a steady supply of skilled talent for the nation's workforce. The program focuses on developing industry-ready graduates, promoting collaboration between industry and academia, and creating employment opportunities for students. Talent Corp partners with the Ministry of Education (MOE) to achieve these goals.

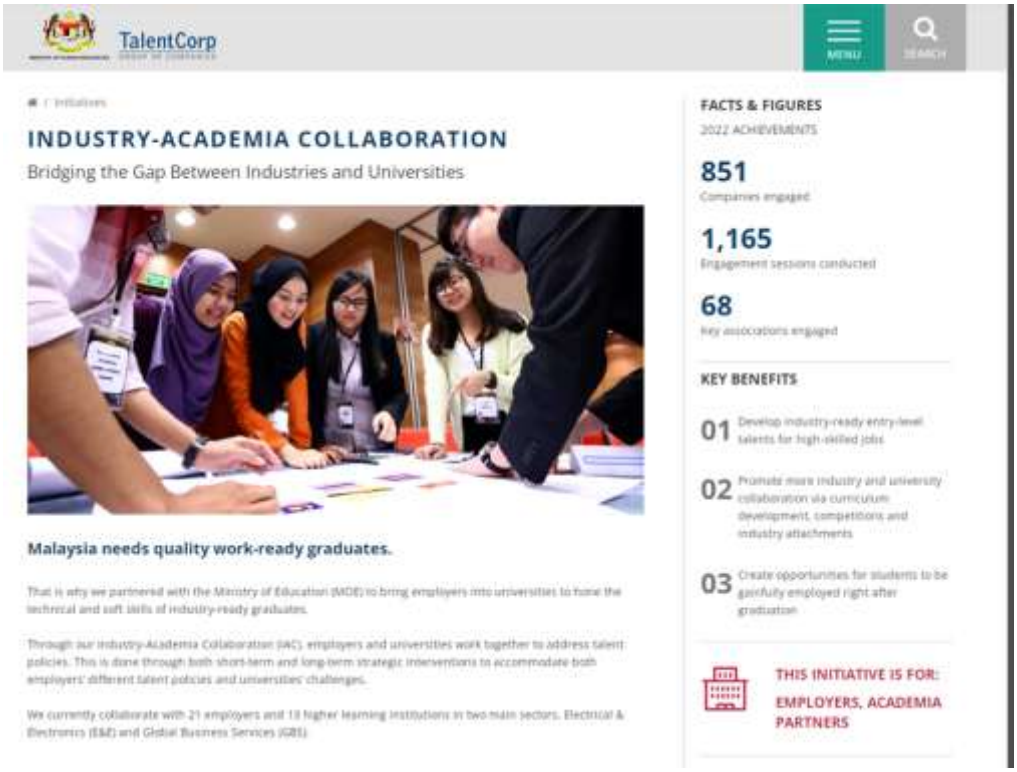


Figure 5.4: Talent Corp's Industry-Academia Collaboration (IAC) program, which aims to bridge the gap between industries and universities.

Introduce Electronics and Robotics Early

Expand programs like after-school robotics clubs, coding classes, and maker labs in secondary schools (and even upper primary). Partner with tech companies to sponsor these (some CSR programs already do). Evidence from a The Star report shows initiatives to stem the loss of STEM interest are underway but need scaling. Provide modest funding for schools to buy Arduino sets, basic electronics kits, etc. and train teachers to guide students in using them. The hands-on experience can ignite interest far better than textbook science.

Career Awareness Campaigns
Launch a campaign e.g., "Future Innovators Malaysia", that sends teams of young engineers or tech entrepreneurs to schools and colleges to talk about their work and opportunities in electronics. This can be coordinated with industry associations (e.g., the Malaysian Semiconductor Industry Association, MSIA). Use social media and perhaps a TV documentary series highlighting "A Day in the Life" of a semiconductor engineer, a data scientist, etc., to glamorize and demystify these careers. According to research on career choice, relatable role models and awareness of job prospects strongly influence students. If students see that electronics can lead to working on cutting-edge tech that changes the world (like developing chips for medical devices or sustainable energy), they may be more inclined to pursue it, countering the perception issue noted in Case 6.

Scholarships and Bonding for Critical Fields
In addition to scholarships, implement a *forgivable loan* scheme: students who study E&E or computer engineering get a loan that is waived if they work in Malaysia in the industry for, say, 5 years post-graduation. This simultaneously addresses brain drain and the pipeline. Countries like Taiwan used bonding effectively decades ago to build their tech talent pool for Hsinchu Science Park.

Enhance Postgraduate Training
Encourage more postgraduate (Masters/PhD) specialization in electronics-related fields by funding research assistant positions and industry-sponsored postgraduate programs such as MyBrain. For example, a company might sponsor employees for a Master's in Microelectronics part-time; the government can co-fund that. Higher qualifications can lead to more advanced R&D and innovation roles within firms. It also creates a pool of future academics to sustain the teaching of these subjects.

5.2.3 Inspiring the Next Generation to Pursue Engineering Careers
The declining interest in engineering among Malaysian youth necessitates a multifaceted approach. Revamping the education system is essential to make engineering more engaging. Schools should adopt active learning methods such as project-based learning, hands-on activities, and real-world problem-solving. These approaches demonstrate the creative and practical aspects of engineering, moving away from rote memorization that often dampens student interest. Building on the theme of inspiration, the government can spearhead national-level competitions and programs that make engineering and innovation *aspirational*:

National STEM Competitions and Camps
Expand events like Science fairs, hackathons, and engineering design competitions. A notable idea is an annual *National Electronics Design Challenge* for university and polytechnic students, where teams solve a real industry problem (e.g., design a device or process improvement). Provide attractive prizes, internships for winners, and publicity. Such experiences often solidify students' passion for the field and also showcase talent to recruiters.

Youth Tech Talent Programs
Consider something akin to Malaysia's version of FIRST Robotics (which in the US greatly increased youth interest in robotics). Programs can culminate in international competitions. In fact, Malaysia can collaborate regionally – e.g., a Malaysia-Singapore Youth Tech Challenge – fostering both skills and cross-border networks.

Mentorship Initiatives
Establish a mentorship program where young professionals in the electronics industry mentor secondary or pre-university students interested in STEM. This personal guidance can sustain a student's motivation through challenging courses. Possibly managed via an online platform, mentors can share advice, help with project ideas, and encourage mentees to pursue engineering in tertiary education.

Media and Outreach
Work with popular media to create content that positively portrays engineers and innovators. This could be something like a reality TV show following student teams in a tech competition or a drama featuring a protagonist who is an engineer making a social impact (to break the stereotype that these careers are uninteresting). The influence of media on career perception is subtle but significant.

Teaching Method Reform
Modernizing teaching methods in engineering education involves integrating technology, interactive tools, and engaging approaches to create a more dynamic and stimulating learning experience. By leveraging advancements such as virtual labs, simulations, and digital platforms, educators can make complex concepts more relatable and accessible to students. These innovative methods not only enhance understanding but also foster greater interest and active participation in the learning process, preparing students for real-world challenges in their field.

Redefining Engineering for the Modern Era
To reshape public perceptions, engineering must be actively promoted as a diverse and dynamic discipline integral to solving global challenges, including sustainability, digital transformation, and technological innovation. Emerging fields such as software, data, electronics, materials, and manufacturing engineering present unprecedented opportunities for creative problem-solving and impactful innovation. To ensure these areas receive the attention they deserve, the Board of Engineers Malaysia (BEM) could revise its structure to prioritize and elevate these disciplines, underscoring their critical contributions to society. Public awareness initiatives can further bolster this effort by showcasing how engineers drive transformative change across industries and create solutions for a more sustainable future.

Cultivating Future Talent Through STEM Engagement
Inspiring the next generation of engineers requires targeted engagement through STEM outreach programs. Organizing workshops, talks, and mentorship opportunities led by successful engineers from diverse and emerging specializations can ignite student interest and broaden their understanding of the multifaceted nature of engineering careers. Equally important is addressing outdated stereotypes that confine engineering to traditional construction or manufacturing roles. Strategic campaigns should emphasize the field's versatility, highlighting its applications in areas such as artificial intelligence, renewable energy, and advanced manufacturing. By presenting engineering as a future-oriented, innovative, and inclusive field, these efforts can attract a broader and more diverse audience to explore its boundless possibilities.

Enhancing Work-Life Balance in Engineering Careers
Work-life balance and competitive compensation are also vital for attracting young talent. Flexible work arrangements and transparent career progression pathways can address the concerns of modern professionals. Additionally, parental and societal perceptions must shift to view engineering as a fulfilling and impactful career. Schools can integrate career guidance

programs, while government and industry can collaborate on media campaigns featuring inspiring success stories of Malaysian engineers.

5.2.4 Fostering Academic and Industry Synergy: Key Partnerships for STEM Advancement

To ensure alignment between educational output and industry needs, more structural partnerships should be forged:

Adopt-a-School/University Programs

Encourage each major electronics company or MNC in Malaysia to "adopt" a local technical school, polytechnic, or university department. Adoption means providing input on curriculum, donating equipment, offering internships, and training teachers or lecturers periodically. For instance, a company like Intel or Infineon could adopt a polytechnic's electronics department, upgrading their microchip testing lab to industry standards, thus directly enhancing the skill-readiness of graduates. The government can recognize and perhaps incentivize these adoptions (e.g., through CSR tax deductions or awards).

Public-Private Talent Development Initiatives

Use bodies like the Penang Skills Development Centre (PSDC) as a model. PSDC is a successful tripartite initiative (industry, government, academia) that has been upskilling workers for decades. Replicate PSDC-like centres in other regions (e.g., in Klang Valley or Johor) focusing on local industry needs but under a national network ensuring quality and sharing curricula. The Eastern Economic Corridor (EEC) in Thailand has similar training partnerships, actively engaging foreign and local companies to train workers for new high-tech investments. Malaysia should similarly anticipate talent needs for strategic investments (like if a new big semiconductor fab is expected, pre-train a workforce for it via such centres).

International Partnerships for Talent
Leverage international cooperation to build talent. For example, revive or expand agreements with countries like Japan, Germany, or the US for specialized training. Perhaps a certain number of Malaysian students or workers could be sent annually for training or internships in those countries' top electronics firms or labs (on the condition they return). The Japanese "ABK-AOTS" training scheme and Germany's "Dual Vocational Training" partnerships with countries are possible models. This not only builds skills but fosters networks and exposure to world-class practices.

Government-Led Initiatives for Digital Advancement
Malaysia has implemented several government initiatives aimed at fostering digital talent, supporting startups, and promoting STEM education. The **Malaysia Digital Economy Corporation (MDEC)** plays a pivotal role in these efforts, offering programs like the Global Digital Talent Programme (GDTP), which focuses on developing local digital talent to meet industry demands. Additionally, MDEC provides support to startups and entrepreneurs in the technology sector, ensuring a conducive ecosystem for innovation and growth.

Scholarships and Financial Aid for STEM Students
The **Ministry of Higher Education (MOHE)** complements these efforts by offering scholarships and financial aid to students pursuing STEM degrees. MOHE also actively implements programs to enhance the STEM education curriculum and improve teaching methodologies, ensuring that the education system aligns with the needs of a rapidly evolving technological landscape.

MOSTI's Role in Driving Scientific Innovation
Further support comes from the **Science, Technology, and Innovation Ministry (MOSTI)**, which funds research and development projects across various fields. MOSTI also provides grants and incentives for businesses in STEM-related industries, encouraging innovation and the commercialization of new technologies.

Strengthening STEM Through Industry Collaboration
Industry partnerships play a significant role in supporting STEM education and bridging the gap between academia and industry. Programs such as the **Intel Internship Program** provide students pursuing STEM degrees with practical experience and exposure to the electronics industry, fostering skills that are directly applicable to their future careers. The **Maybank Foundation Scholarship** focuses on financial inclusion by supporting students in STEM-related fields, ensuring equitable access to education and opportunities. Similarly, the **Petronas Education Sponsorship Program** offers scholarships and grants to students and researchers, promoting advancements in STEM education and innovation. Additionally, **Tenaga Nasional Berhad (TNB)** provides specialized scholarships and training programs designed for engineering graduates, contributing to a highly skilled workforce in the energy and infrastructure sectors. These initiatives collectively underscore Malaysia's commitment to cultivating a robust STEM talent pipeline and fostering innovation across industries.

5.2.5 Addressing Brain Drain Challenges in Malaysia

The challenge of brain drain in Malaysia poses a significant threat to the nation's economic growth and development. Retaining top talent requires a comprehensive and strategic approach that addresses the root causes of talent outflow, including wage disparities, a lack of meritocracy, and limited career advancement opportunities. Emerging economies such as Taiwan, South Korea, and China provide valuable lessons, demonstrating that targeted policies,

inclusive practices, and competitive incentives can effectively reverse brain drain. Finally, to mitigate brain drain and even turn it into "brain gain":

The Limitations of Malaysia's Minimum and Graduate Wages

One of the key factors driving brain drain in Malaysia is the disparity in salaries, particularly for skilled professionals and fresh graduates. While the RM1,500 minimum wage serves as a benchmark for unskilled workers, starting salaries for graduates often fail to reflect their expertise and potential contributions. Economists have criticized this low salary benchmark as a regressive approach that undermines efforts to build a competitive and sustainable workforce. For instance, the typical RM2,500 starting salary for fresh graduates is far from a sustainable living wage, especially when compared to neighbouring countries. To address this issue, the government must revise wage policies to ensure starting salaries are aligned with productivity and market standards. Moreover, career advancement pathways should be made clearer and more rewarding, offering professionals tangible reasons to stay in Malaysia.

The Impact of Weak Meritocracy on Talent Retention

Another critical factor is the lack of meritocracy in hiring, promotions, and access to funding. Countries like China, South Korea, and Taiwan have successfully implemented merit-based systems that reward talent and performance. For example, China's National Talent Development Plan has introduced industry-specific schemes to attract top local and foreign experts, fostering reverse migration. Similarly, South Korea and Taiwan have developed their technological capabilities and created high-quality jobs, elevating living standards and retaining skilled talent. Malaysia can learn from these examples by adopting transparent policies that ensure equal opportunities for all citizens, regardless of background. This includes fair appointments, promotions, and equitable access to research funding and government resources. A transparent and accountable system is essential to foster trust and encourage talent retention.

Government-Led Incentives to Reverse Brain Drain

The Malaysian government has already introduced initiatives like the Returning Expert Program, which provides incentives such as a flat 15% tax rate and permanent residency for returning skilled professionals. While these measures are steps in the right direction, they require further expansion and alignment with global best practices to remain competitive. For example, South Korea offers tax-free incentives and substantial benefits to skilled foreign professionals, creating a more attractive environment for talent retention. Evaluate the current REP (which offers tax incentives for Malaysian professionals abroad to return) and increase its attractiveness. For example, broaden eligibility, increase the income tax holiday duration (perhaps from 5 to 10 years for critical skill holders), include partial moving expense coverage, and fast-track permanent residency for foreign spouses of returnees. Promote success stories of Malaysians who came back and thrived, to encourage others. The government could also coordinate with industries to ensure returnees find suitable positions (perhaps a job-matching portal specifically for Malaysians abroad).

From Race-Based to Need-Based Policies

Feedback from the Malaysian diaspora suggests that shifting from race-based to need-based affirmative action would enhance inclusiveness and equity. This paradigm shift could reduce systemic disparities and provide a more level playing field for all Malaysians, fostering a sense of belonging and fairness. Additionally, reducing government intervention in the economy and adopting international standards for pay and benefits could make Malaysia a more competitive destination for skilled talent.

Education as a Strategic Response to Brain Drain
Education and workforce development also play a pivotal role in addressing brain drain. Investments in quality education and training systems, particularly in STEM fields, can increase employability and productivity. Restructuring vocational training to match market needs and addressing disparities in education quality between rural and urban areas are essential steps. By enhancing the education-to-employment pipeline, Malaysia can produce a workforce that meets the demands of a globalized economy.

Engage the Diaspora
Set up a formal network (if not already) – e.g., an online portal or annual conference – connecting Malaysian diaspora in tech (Silicon Valley engineers, etc.) with opportunities back home. Invite them for short-term stints (like a 2-week "tech tourist" program where they visit and consult for local firms, with costs partly covered). This maintains ties and could sow seeds for eventual return or investment. Countries like India and China have effectively used diaspora networks to mentor local startups and even fund them; Malaysia can replicate these ideas in the electronics startup space or in academia (invite diaspora experts as adjunct professors or advisors on research projects).

Improve Local Work Environment
Some aspects of brain drain require improving what's on offer in Malaysia: competitive compensation (here the government can't force higher salaries but can lead by example in R&D centers, and encourage higher-value activities that pay more), research infrastructure (invest in state-of-the-art labs to attract researchers back), and intangibles like promoting meritocracy and reducing workplace bureaucracy. While broader, policies that create a vibrant, innovation-driven domestic industry themselves will attract talent to stay or return, because exciting work and career growth can happen here.

Leverage Foreign Talent Wisely
In parallel, while developing local talent, remain open to importing skills where needed. Simplify visa and employment pass processes for high-skilled foreign workers in the electronics sector. They fill immediate gaps and also can train locals. However, ensure knowledge transfer by pairing foreign experts with local understudies (perhaps make that part of the condition for approving a certain number of expat positions). Over time, reliance on foreign talent should lessen as local capacity builds, but in the interim it helps keep industry performance up (as seen in some case examples).

Building a Competitive and Productive Labour Market
Lastly, creating a more competitive labour market through policies that reward productivity and formalize SME business practices can address underlying structural issues. Improving public services, living standards, and the overall quality of life can further incentivize top talent to remain in or return to Malaysia. These measures, combined with active engagement with the diaspora and ongoing policy refinement, are crucial to reversing brain drain and fostering sustainable economic growth.

The brain drain issue is complex, but our recommendations approach it both by making Malaysia more attractive and by maintaining engagement with those who left. This aligns with best practice as identified by the World Bank and others – successful cases like Taiwan and China saw many expats return once local opportunities improved, especially during the current

trade war between USA and China; Malaysia needs to reach that tipping point by consciously improving conditions and actively wooing its talent back.

Up to now, the policy recommendations on talent incorporate lessons from high-impact sources like Harvard Business Review on talent (Cappelli 2008) which suggested modern talent management strategies, and academic sources on strategic talent (Collings & Mellahi 2009) advocating a systematic approach. We implicitly follow those by recommending structured programs and alignment. By addressing wage disparities, fostering meritocracy, enhancing inclusiveness, and investing in education and public services, Malaysia can transform brain drain into brain gain, paving the way for a high-income, innovative economy.

5.3 Suggestions for Refining the Regulatory Environment

The regulatory environment plays a crucial role in shaping the competitiveness of Malaysia's electronics sector. A streamlined, transparent, and adaptive regulatory framework can attract investments, encourage innovation, and ensure that local businesses remain compliant with international standards. These measures are particularly important given the rapid pace of technological advancements and increasing global demands for sustainability and ethical practices. The following recommendations target these goals:

5.3.1 Government's Role in Improving the Regulatory Environment

To create a conducive business environment, the Malaysian government must adopt a proactive approach to reforming regulatory systems. At the state level, the Penang government can lead the way by simplifying bureaucratic processes, enhancing regulatory fairness, and ensuring stability and predictability in policies.

Launching a Nationwide Regulatory Guillotine Initiative

To enhance regulatory efficiency and foster a more business-friendly environment, Malaysia should undertake a comprehensive Regulatory Guillotine (Streamlining) Exercise to identify and eliminate outdated, redundant, or unnecessarily time-consuming regulations. For instance, where multiple agencies require similar documentation, a unified submission process should be adopted to reduce duplication and administrative burden. Building on the success of the MalaysiaMudah initiative, which improved the ease of starting a business, a similar sector-specific effort is needed, particularly in streamlining permits for factory licensing, environmental approvals, and duty exemptions. Applying lean management principles, authorities can map and analyze existing processes to eliminate steps that do not add value or are not legally mandated, thereby significantly reducing approval times. This approach mirrors Indonesia's OSS system, which successfully consolidated various permits into a single digital platform, leading to substantial time savings. Additionally, reforms should prioritize digitalization of licensing and registration systems to lower compliance costs and time, especially for SMEs. Strategic collaboration with federal bodies like the Malaysian Productivity Corporation (MPC) is vital to align state-level efforts with national objectives, ensuring regulatory consistency and maximizing impact across all tiers of government.

One-Stop Digital Platform

Accelerate the development of a single digital window for all manufacturing-related approvals that if not fully implemented. This platform should allow companies to apply for multiple licenses/permits through one interface, track application status in real-time, and interface between different government agencies behind the scenes. Malaysia's **OSS (One Stop Service)** similar to Indonesia's should be priority. A strong example is how Singapore's GoBusiness portal centralizes license applications. By benchmarking processing times against those of

regional competitors (like aiming to approve factory permit in X days, matching best in ASEAN), Malaysia can set concrete service level targets for agencies.

Regulatory Impact Assessment (RIA)
Institutionalize RIA for any new regulation affecting industry. This means before introducing or revising regulations, consult with stakeholders (industry associations, SMEs) and analyze the cost-benefit, to avoid unintended burdens. This practice, encouraged by the OECD, ensures smarter regulation. For instance, if a new environmental regulation on e-waste is proposed (which is good in principle), RIA can help design it such that compliance is feasible for SMEs (maybe phased introduction or providing support).

Ensuring Fair and Consistent Regulation
A transparent and equitable regulatory framework is vital for fostering trust among industry stakeholders. By strengthening enforcement mechanisms and training regulatory personnel, the government can ensure that safety, environmental, and competition laws are applied uniformly. Such measures create a level playing field for businesses and promote healthy competition.

Enhancing Policy Stability and Predictability
Investors and businesses thrive in environments where regulations are clear and predictable. Regular consultations with industry stakeholders can help the government align regulations with market demands. Advocacy at the federal level for regulatory stability can also bolster investor confidence, encouraging long-term investments in Malaysia's electronics sector.

5.3.2 Simplifying Regulatory Procedures

Simplification of regulatory procedures is a priority for creating a business-friendly environment. A key step is to streamline the process for registering businesses and obtaining necessary licenses. This can be achieved through the consolidation of application forms, the reduction of redundant steps, and the implementation of online platforms. Beyond high-level streamlining, the government should simplify specific procedures known to be pain points for electronics firms:

Customs and Trade Facilitation
Simplify import/export processes for high-tech equipment and components. For materials that are crucial and frequently imported (chemicals, components), consider a "**green lane**" for certified companies where inspections are minimal (perhaps implement an Authorized Economic Operator program more fully for tech firms). Increase automation in customs clearance – more e-declarations and use of risk-based automated approvals. The recent experience with aluminum import delays (from Case 9) can be addressed by pre-clearing standardized inputs. If a material is globally approved, allow it expedited entry (with post-market surveillance rather than pre-entry testing when appropriate). Implement systems like **Malaysia's National Single Window** more robustly, and integrate it with port systems to avoid delays.

Work Permits for Skilled Foreign Talent
Simplify and expedite the issuance of professional visit passes and employment passes for highly skilled foreign workers in the electronics sector. If a company needs to bring in an expert, it should not take months of paperwork. Perhaps create a category of "Tech Experts Pass" with a fast turnaround (2-4 weeks) for roles that are on a critical skills list. Singapore recently introduced a Tech.Pass for top tech talents globally – Malaysia could do similar on a smaller scale to attract niche experts, which indirectly helps train local teams. Also, reduce bureaucratic

hurdles for renewals if the person is contributing value (streamlined renewal for those in good standing).

Local Authority Approvals
Often, even after national-level approvals, businesses face local government procedures (business premises licenses, building permits for expansions, etc.). The federal government should work with state and municipal authorities, especially in key industrial areas (Penang, Kulim, Shah Alam, Johor), to harmonize and fast-track these local approvals for electronics manufacturers. Possibly extend the one-stop centre concept to local level (some places have Pusat Sehenti but ensure it works effectively). A company should be able to, for example, extend its factory with parallel processing of building plan approval and environmental assessment, rather than sequential. Where feasible, **self-certification** by licensed professionals (like engineers certifying building safety) should be accepted to speed up processes, subject to audit.

One-Stop Regulatory Portal
One innovative solution is the development of a **One-Stop Regulatory Portal**, which would integrate all regulatory requirements into a single online and physical hub. This portal would enable businesses to access information, submit documents, and receive approvals from multiple agencies, reducing inefficiencies. Such a system would be particularly beneficial for SMEs and in addressing complex processes like hiring expatriates.

5.3.3 Enhancing Regulatory Transparency and Consistency
Unpredictability in enforcement or sudden changes can deter investment. The government should improve transparency in regulatory matters:

Clear Guidelines and Communication
For each major regulation affecting electronics (e.g., environmental regulations on chemical handling, labour laws on overtime, etc.), ensure there are up-to-date guideline documents or online resources that explain in plain language what companies must do to comply. Often SMEs struggle because they don't have dedicated legal teams to parse complex regulations. MITI and related agencies can publish sector-specific compliance handbooks. Also, whenever there's a regulatory change, give adequate advance notice and perhaps conduct briefing sessions/webinars for industry. This prevents situations where companies are caught off-guard by new rules.

Consistent Enforcement
Address inconsistencies by training and capacity-building for regulatory officers. One case issue was variable interpretation by officers (e.g., at different ports). Standardize training and use checklists so that enforcement becomes more uniform. Increase inter-agency communication to avoid contradictory demands on firms. The government could also implement a feedback mechanism: allow companies to anonymously report instances of inconsistent or unjust application of rules to a central body. This not only helps catch possible malpractice (corruption) but also highlights where guidelines might need clarification.

Regular Public-Private Dialogues
Institute a formal quarterly or biannual dialogue between the electronics industry (through associations like MSIA, FMM E&E committee, etc.) and regulators (customs, immigration, standards bodies, etc.). In these meetings, issues can be raised and clarified. This continuous feedback loop ensures regulators understand industry realities and can adjust. It also reassures

businesses that their voices are heard, improving trust in regulatory institutions. For example, if companies consistently raise that a certain approval takes too long, the agency can explain or commit to improvement by next meeting.

Building Trust Through Transparent Regulations
Clear, accessible, and consistent regulations build trust and encourage compliance. The government should establish comprehensive guidelines for businesses, covering areas such as environmental standards, safety protocols, and labour laws. Regular updates and training programs for regulatory bodies, such as customs and SIRIM inspectors, can ensure uniform application of rules across industries.

By improving transparency and consistency, Malaysia not only reduces friction but also builds a reputation as a reliable place for business. This addresses investor concerns and can be a selling point in attracting high-tech foreign investment or even encouraging local entrepreneurs to start ventures without fear of regulatory "surprises."

5.3.4 Promoting Regulatory Flexibility and Adaptation

As technology evolves quickly, regulations must be adaptive:

Regulatory Sandboxes
Establish sandboxes for areas of innovation where existing regulations might inhibit experimentation – e.g., drones in manufacturing logistics, or new chip fabrication techniques that don't fit current environmental categories. Within a sandbox, firms can trial innovations under relaxed rules but with oversight to manage risks. If the trial is successful, regulators can then formalize appropriate regulations. Malaysia has done this in fintech; extending the concept to manufacturing tech and Industry 4.0 innovations would foster development. For instance, a company wanting to pilot an autonomous factory guided by AI could get temporary exemptions from certain manning regulations or real-time regulatory guidance in the sandbox.

Sunset Clauses and Periodic Review
Introduce sunset clauses for new regulations in fast-changing domains, meaning they expire unless reviewed and renewed. This forces re-evaluation in light of technological progress. For example, any regulation on, say, AI use in manufacturing could be reviewed every 2 years because the field moves so fast that rules might need updating.

Benchmarking and Adapting International Standards
Make it a policy to actively monitor international standards (ISO, IEC, etc.) and quickly adopt or adapt them as Malaysian standards to avoid lag. Use the Standards Malaysia department to engage industry experts in standard-setting committees so that as new standards (like for IoT security or for EV electronics safety) emerge, Malaysia is either aligning or contributing. Aligning local regulations with international standards (like RBA for labour, or IPC standards for PCB manufacturing) ensures local companies are not blindsided when global customers demand those standards. It also makes it easier for local companies to certify and export.

This flexibility ensures that regulation becomes a facilitator of innovation rather than a static barrier. It shows foresight by not only solving today's problems but by building capability to handle future ones.

5.3.5 Strengthening Public-Private Dialogue for Policy Coherence

To develop effective and coherent regulations, it is essential to engage industry stakeholders not only during enforcement discussions but also from the earliest stages of policy formulation. Including representatives from the electronics sector in policy working groups, covering areas such as education, trade, and incentives, ensures that new policies are aligned with industry realities and operational needs. This inclusive process leads to more coordinated and practical outcomes. A notable example is the National Industry4WRD policy, which incorporated extensive input from industry players. Similar engagement should be pursued for future initiatives such as the National Fourth Industrial Revolution Policy and the execution of the Digital Economy Blueprint. It is particularly important to integrate the perspectives of the electrical and electronics industry, given its significant contribution to the national economy.

Regular communication between the government and industry stakeholders should be institutionalized through advisory councils or dedicated working groups. These platforms allow for the discussion of regulatory challenges and the identification of practical solutions. In addition, conducting impact assessments prior to implementing new regulations can help policymakers understand potential consequences on business operations and national competitiveness. This collabourative approach helps to ensure that regulations remain effective, consistent, and business-friendly while supporting long-term innovation and economic growth.

5.3.6 Supporting Compliance Through Incentives

To encourage compliance, the government should offer incentives such as tax breaks, subsidies, or reduced fees for businesses that prioritize sustainability, worker safety, and innovation. Training programs and resources for understanding regulatory requirements can further ease the compliance burden, especially for SMEs. Use carrots, not just sticks, to encourage companies to comply with or exceed regulatory requirements:

ESG Incentives

Provide incentives for companies that voluntarily adhere to high standards of ESG (Environmental, Social, Governance) beyond what's legally required. E.g., a slight corporate tax reduction or additional grant eligibility for firms that achieve international certifications (ISO 14001 for environment, RBA compliance for labour, etc.). Thailand's SEC required ESG training; Malaysia could on one hand mandate (or strongly encourage) sustainability reporting for large companies, but also recognize those efforts by preferential consideration in government procurement or awards. Essentially, reward good behavior to create demonstration effects.

Compliance Assistance Programs

Offer technical assistance to help SMEs in the electronics sector comply with complex regulations (environmental, quality). For instance, an **Environmental Compliance Assistance Scheme** could send consultants (partly subsidized) to electronics factories to advise on waste management improvements and prepare them for audits, rather than only penalizing them after violations. This proactive stance can improve overall compliance levels.

In summary, regulatory compliance should be positioned as a mutually beneficial process. By providing clear guidance, practical support, and aligning compliance with meaningful incentives, businesses are more likely to view regulations as enablers rather than burdens. This approach fosters a culture of voluntary compliance, continuous improvement, and shared commitment to national standards and goals.

5.3.7 Enhancing Cross-Border Regulatory Harmonization

Harmonizing Malaysia's regulatory frameworks with ASEAN standards is critical for facilitating cross-border trade and attracting foreign investment, particularly in the highly interconnected electronics industry. Establishing and expanding **Mutual Recognition Agreements (MRAs)** with key trading partners would significantly streamline compliance processes, reduce duplication in testing and certification, and accelerate market access for Malaysian firms.

The Malaysian government should actively support the implementation of the **ASEAN Single Window** and promote regional MRAs for electrical and electronic equipment. Under such arrangements, a product certified by recognized authorities such as SIRIM in Malaysia would be accepted across other ASEAN member states, and vice versa. This alignment reduces costs, eliminates redundant procedures, and enhances overall efficiency. Achieving this requires harmonization of technical standards and mutual trust in conformity assessment mechanisms among ASEAN countries.

Beyond the region, Malaysia should engage in regular dialogues with major global partners, including the European Union, the United States, and China, to monitor emerging regulatory developments such as the EU's Carbon Border Adjustment Mechanism (CBAM) and evolving semiconductor export controls. Proactive engagement would help Malaysian firms anticipate regulatory shifts and adapt accordingly. Where necessary, the government should negotiate phased transition periods to mitigate sudden compliance burdens on local exporters.

To strengthen regional leadership, Malaysia could propose the establishment of an **ASEAN Electronics Compliance Hub**. This initiative would serve as a centralized platform providing comprehensive regulatory information for companies operating within ASEAN, further reinforcing Malaysia's role as a hub for electronics innovation, compliance facilitation, and trade integration.

5.3.8 Investing in the Digitalization of Regulatory Processes

The digitalization of regulatory processes offers significant potential to enhance efficiency, transparency, and responsiveness across government agencies. Implementing robust e-Government solutions that automate documentation, compliance tracking, and regulatory updates can substantially reduce administrative burdens for businesses, particularly small and medium enterprises (SMEs). By streamlining workflows and minimizing manual interventions, digital tools can accelerate approval timelines and improve the user experience for regulated entities.

To ensure the effectiveness of digitalization efforts, investment must extend beyond front-end one-stop service portals to include the modernization and interoperability of back-end systems. Licensing databases, enforcement monitoring tools, and regulatory tracking platforms should be upgraded to ensure seamless data sharing and real-time processing across departments. Allocating dedicated budgets for legacy system upgrades and staff training in digital competencies is essential to sustain long-term system resilience and usability.

Additionally, leveraging data analytics enables regulators to monitor key performance indicators, such as application processing times, compliance trends, and workflow efficiency. For example, tracking whether 90 percent of factory license applications are processed within a specified timeframe can help agencies identify systemic bottlenecks and implement corrective measures. Digital systems also enhance transparency by making application statuses

visible to stakeholders, and they reduce opportunities for corruption by ensuring interactions are logged, traceable, and, where appropriate, automated. Collectively, these measures contribute to a more responsive, data-driven, and trustworthy regulatory environment.

5.3.9 Fostering a Business-Friendly Regulatory Culture

Ultimately, regulations are implemented by people. Therefore, it is important to cultivate a culture among regulators that views businesses as partners in national development rather than as adversaries. This cultural shift can be achieved through several targeted initiatives:

Customer Service Training for Regulators

Regulatory agency staff should be trained to adopt a supportive and solution-oriented approach, especially when dealing with small businesses. Instead of acting solely as gatekeepers, officials should provide guidance and assistance. For example, if an application is missing information, staff should reach out to help applicants complete the process rather than rejecting the submission outright.

Performance Metrics for Agencies

Regulatory agencies should include client satisfaction as part of their performance evaluation. Regular surveys can be used to assess business experiences with these agencies, and summary results should be made public. Agencies that maintain high satisfaction levels while upholding regulatory standards should be acknowledged and incentivized. This promotes accountability based not only on processing volume but also on quality of service.

Anti-Corruption Vigilance

Integrity is fundamental to building a business-friendly environment. Strong measures must continue to prevent bribery and ensure fair treatment in the issuance of permits or approvals. Encouraging the use of e-payments and official digital platforms can minimize face-to-face cash transactions, reducing opportunities for misconduct. The Malaysian Anti-Corruption Commission (MACC) should work closely with regulatory bodies to implement preventive controls that strengthen transparency. A clean and predictable regulatory environment gives both local and foreign investors confidence in the system.

By fostering this kind of professional and collabourative culture, Malaysia can set a new standard for regulatory engagement. Over time, the expectation will grow that dealing with regulators is straightforward and fair. This shift can provide a significant competitive advantage. Countries such as New Zealand often rank highly in ease of doing business not only due to streamlined procedures but also because of their service-oriented regulatory mindset. Malaysia can work toward achieving a similar standard.

5.3.10 Addressing Challenges in Implementing RBA Standards

The RBA Code of Conduct presents growing compliance challenges for Malaysian electronics manufacturers, particularly SMEs, due to the substantial resources required. As international scrutiny on labour practices, environmental sustainability, and ethical standards intensifies, it is critical that Malaysia proactively supports its electronics sector in aligning with global expectations. Compliance with the RBA framework is no longer just a moral obligation; it has become an economic necessity to sustain participation in high-value global supply chains.

To address this, the Malaysian government should implement a multi-pronged strategy that includes both short-term assistance and long-term structural reform:

A. Develop National Guidelines Aligned with RBA Standards
A national E&E industry code that mirrors the RBA requirements should be introduced, covering areas such as working hours, dormitory conditions, safety standards, and grievance mechanisms. While voluntary in nature, this code should carry government endorsement and include implementation toolkits and templates to assist companies in adopting best practices.

B. Strengthen Auditing and Compliance Support
Agencies such as SIRIM or accredited third parties should establish a diagnostic audit scheme for RBA compliance. These audits should be non-punitive in their initial phase, focusing on identifying gaps and helping firms develop corrective action plans. Government funding support should be made available to assist SMEs in upgrading infrastructure, such as dormitories or safety systems, to meet RBA expectations.

C. Introduce Financial Incentives and Compliance-Based Fast-Tracking
Financial assistance in the form of grants or matching funds should be extended to help firms meet the costs of compliance-related activities, including audits, training, and infrastructure upgrades. Companies that demonstrate compliance with RBA standards could be fast-tracked for certain government incentives, positioning ethical governance as a competitive advantage.

D. Integrate RBA Tenets Gradually into National Regulation
Over time, key elements of the RBA Code should be incorporated into Malaysian labour laws and industrial regulations to ensure a level playing field. This process should be undertaken in consultation with stakeholders to ensure practicality. For example, enforcing a 60-hour workweek limit, already aligned with the RBA and generally consistent with current Malaysian law, can be implemented more strictly. Practices such as passport withholding, which are already illegal, must also be more consistently enforced.

E. Promote Alignment with Global ESG Standards
The government should encourage the adoption of green technologies and renewable energy to meet European Union carbon standards and other emerging international regulations. Investment in research and development for sustainable processes and products should be supported through incentives and grant programs. Capacity building programs should also integrate training on the RBA, the EU's Carbon Border Adjustment Mechanism (CBAM), and the Corporate Sustainability Due Diligence Directive (CSDDD) to ensure the workforce is equipped to manage evolving requirements.

F. Foster Strategic Engagement with Buyers and International Partners
Malaysia should engage major trading partners, including the European Union, the United States, and China, to stay informed on upcoming regulatory changes and secure transition arrangements where needed. Additionally, leveraging buyer requirements can reinforce national compliance. Many multinational corporations already demand RBA compliance from their Malaysian suppliers. The government can amplify this by encouraging RBA alignment as a baseline requirement for participation in public-sector projects or funding schemes.

G. Establish a Regional Compliance Resource Hub
Malaysia could take the lead in initiating an ASEAN Electronics Compliance Hub. This platform would provide consolidated regulatory information, support services, and best practices to assist businesses operating across Southeast Asia, reinforcing Malaysia's position as a regional leader in ethical and sustainable electronics manufacturing.

By implementing these measures, Malaysia can significantly reduce regulatory friction, enhance its attractiveness to high-value investors, and ensure that the growth of its electronics sector remains sustainable, ethical, and competitive. A transparent, predictable, and supportive regulatory environment will enable firms to focus on productivity and innovation, both of which are essential to national development and aligned with the future-oriented goals of technological forecasting and social change.

5.4 Sustainable Growth Strategies: Adapting Proven Models from Asian Economies

To foster sustainable growth and bolster Malaysia's position as a competitive global economy, it is crucial to draw insights from the strategies employed by successful Asian economies. Countries such as Singapore, South Korea, Japan, and Vietnam have demonstrated remarkable economic progress by implementing forward-thinking policies, fostering innovation, and cultivating robust ecosystems for growth. These nations have excelled in areas like research and development, talent management, regulatory reform, and public-private partnerships, offering valuable lessons for Malaysia.

Table 5.4.1 Global Rankings Across Key Indices for Asian Economies, 2023

Index	Singapore	South Korea	Hong Kong SAR	Japan	China
Global Competitiveness Index (GCI)	2	5	3	6	28
Economic Freedom Index (EFI)	1	3	N/A	N/A	N/A
Ease of Doing Business (EDB), 2020	2	5	3	N/A	31
Global Innovation Index (GII)	1	2	4	5	3
Logistics Performance Index (LPI)	1	3	4	2	5

Notes:

- Rankings marked "N/A" indicate unavailable or unranked countries for that specific index.
- For EDB (2020), Malaysia was ranked 12th globally and 4th in Asia.
- South Korea, Singapore, and Hong Kong consistently perform highly across multiple indices.

Table 5.4.1 highlights the performance of the top five Asian economies: Singapore, South Korea, Hong Kong SAR, Japan, and China; across five major indices: Global Competitiveness Index (GCI), Economic Freedom Index (EFI), Ease of Doing Business (EDB), Global Innovation Index (GII), and Logistics Performance Index (LPI). Singapore consistently leads in all measured indices, showcasing its well-rounded excellence in economic freedom, innovation, business environment, and logistics. South Korea ranks highly in innovation (2nd in GII) and logistics (3rd in LPI), underlining its technological prowess and infrastructure strength. Hong Kong SAR secures top rankings in business environment and innovation, reflecting its role as a global financial hub. Japan excels in logistics (2nd in LPI) and remains a strong contender in innovation (5th in GII). China demonstrates steady progress, ranking 3rd in innovation and maintaining competitive positions in business and logistics. These rankings illustrate the diverse strengths of these economies, with Singapore emerging as a dominant leader across all metrics.

By studying and adapting these proven models, Malaysia can identify effective approaches to address existing challenges, such as talent retention, innovation gaps, and regulatory inefficiencies. The strategies discussed in this section provide a blueprint for leveraging Malaysia's unique strengths while aligning with global trends in technology, sustainability, and

economic resilience. Emulating these practices can accelerate Malaysia's trajectory toward becoming a leading hub for innovation and sustainable development in Asia.

In formulating our recommendations, it is instructive to look at how other Asian economies have successfully developed their electronics and high-tech industries. By adapting elements of these proven models, Malaysia can accelerate its progress. This section highlights strategic initiatives from leading Asian countries that could be emulated or customized for Malaysia's context, ensuring growth strategies are both sustainable and forward-looking:

5.4.1 Innovation for Global Competitiveness: Strategies from Asian Economies

5.4.1.1 Establishing a Centralized R&D Ecosystem

- **Singapore's R&D Ecosystem:** Singapore has built a world-class public research ecosystem (e.g., A*STAR research institutes) that works closely with industryy. Malaysia can mirror this by establishing specialized research centers (as recommended in Section 5.1) and by creating **innovation hubs** or science parks (e.g., expanding Technology Park Malaysia or creating new ones in Johor/Penang) that co-locate startups, MNC R&D centers, and academic spin-offs. Singapore also aggressively funds R&D (over 1% of GDP) – Malaysia's New Economic Policy should similarly prioritize increasing R&D investment to, say, 1.5% of GDP by 2025. This could be achieved by a combination of higher public R&D spending and incentives that spur private R&D (A*STAR, 2022).
- **South Korea's Clusters and Chaebol Partnerships:** South Korea's Daedeok Innopolis and the close collaboration between government and large enterprises (chaebols) fueled rapid innovation (Oh & Yeom, 2012). While Malaysia's industry structure differs, large local or foreign firms (e.g., Intel, Infineon, Malaysian companies like ViTrox) can be encouraged to mentor and develop local suppliers and startups – essentially creating an innovation cluster around them. Government can facilitate this with grants for supplier development or by hosting cluster networking events. Additionally, South Korea's focus on **commercializing research** through tech incubators and tech-focused VCs is something Malaysia can strengthen (e.g., expanding PlaTCOM Ventures' role in commercializing university tech).
- **Taiwan's Science Parks and Talent Circulation:** Taiwan's Hsinchu Science Park thrived by attracting foreign-educated talent back home and concentrating resource. Malaysia's Penang can be analogous, but we need to intensify efforts to attract overseas Malaysians (as per Section 5.2.5) and also make it easy for expatriates to work here. Taiwan also invested heavily in semiconductor education early on; Malaysia might consider setting up a dedicated "Semiconductor Academy" perhaps through a university or as a consortium effort, learning from Taiwan's talent strategies.
- **China's Special Economic Zones and Incentives:** China used special zones (e.g., Shenzhen) with attractive incentives and relatively flexible regulations to spur tech growth. Malaysia could designate specific **Electronics Industry Zones** (or enhance existing Free Industrial Zones) with enhanced incentives: for example, accelerated capital allowances for automation equipment, waiver of import duties on R&D equipment, and even relaxed foreign equity rules for tech firms looking to set up R&D centers (Malaysia already does this generally, but packaging it in zones with one-stop services like InvestPenang provides, makes it more effective). Moreover, China's aggressive use of government procurement to support local tech (while within trade rules) is a lesson – Malaysia's government-related entities should be early adopters of Malaysian electronics innovations (for instance, using made-in-Malaysia IoT sensors in smart city projects)

- **Recommendation**: Malaysia should create a national R&D hub integrating universities, startups, and industry. This hub can offer tax breaks and grants to incentivize innovation, targeting frontier technologies like AI, quantum computing, and advanced semiconductors. Highlight potential industry-specific R&D opportunities and partnerships that can accelerate this initiative.

Insights from Case Study 1: GaN Technology Adoption
Malaysia's experience with Gallium Nitride (GaN) technology, supported by Collaborative Research in Engineering, Science & Technology (CREST), highlights the importance of targeted R&D initiatives. CREST's involvement in GaN epitaxy programs underscores the potential for transcontinental collaborations to attract multinational investments and bolster domestic manufacturing capabilities.

Insights from Case Study 2: Renewable Energy R&D
The development of renewable energy technologies, such as solar PV innovations, through R&D collaborations with international agencies, highlights Malaysia's potential to lead in sustainable electronics.

5.4.1.2 Incentivizing Public-Private Partnerships (PPPs) for Technology Transfer

- **Asia Context**: Thailand's National Innovation Agency facilitates PPPs for technology adoption, streamlining knowledge transfer to SMEs (National Innovation Agency Thailand, 2023). As for Indonesia's Bekraf, the Creative Economy Agency, similarly enhances public-private collaborations to stimulate technological innovation (Indonesian Creative Economy Agency, 2024), while Vietnam's Saigon Hi-Tech Park supports joint ventures between global firms and local startups for tech transfer (Nguyen, 2022).
- **Recommendation**: Malaysia should enhance PPPs by co-funding projects between MNCs, SMEs, and universities. Align funding priorities with high-impact sectors, such as green electronics and energy-efficient systems, to remain globally competitive. Specify the most promising sectors for PPP opportunities, such as renewable energy integration and IoT development.

Insights from Case Study 3: Industry-Academia Synergies
Collaborations between local universities and multinational corporations in Malaysia's semiconductor industry, such as Intel and Western Digital, have shown remarkable success in bridging the technology gap. Expanding these synergies to more universities and industries can further accelerate innovation.

5.4.1.3 Boosting Access to Global Technology Networks

- **Asia Context**: Vietnam's partnerships with Japan and Korea promote technology exchanges, enabling rapid industrial upgrading (Nguyen, 2020). Additionally, the Philippines leverages its IT-BPO industry to form global partnerships for advanced tech training (Almendral, 2024), while Thailand's Eastern Economic Corridor (EEC) actively partners with foreign entities for tech ecosystem development (Eastern Economic Corridor Office, 2021).
- **Recommendation**: Establish bilateral agreements with tech leaders in Asia and beyond to secure access to cutting-edge technologies and expertise. Promote joint ventures that localize manufacturing and innovation. Emphasize joint innovation projects that

address emerging global demands, such as energy storage and advanced communication technologies.

Insights from Case Study 5: Technology Networks
Malaysia's engagements in the ASEAN R&D collaboration platform for AI and IoT highlight the importance of integrating global expertise into local projects. Expanding such platforms can help establish Malaysia as a hub for high-tech innovation.

Insights from Case Study 10: Advanced Manufacturing
Malaysia's adoption of Industry 4.0 principles has enabled advancements in robotics and automation in key electronics sectors. Investments in smart manufacturing facilities, such as fully automated wafer fabs, are essential to strengthen global competitiveness. Extending these innovations to SMEs can create a more inclusive and dynamic industrial ecosystem.

5.4.2 Transforming Talent Development for Future Industries

5.4.2.1 Addressing Skills Gaps Through National Upskilling Initiatives

- **Germany and Switzerland's Dual Education System (adapted via Singapore's SkillsFuture):** While not Asian, this model is instructive and has been adopted in part by Singapore. Emphasizing apprenticeship and vocational excellence (as mentioned in Section 5.2), Malaysia can seek technical cooperation with Germany/Japan to train our vocational trainers and develop industry-certified apprenticeship curricula. The sustainable outcome is a self-reinforcing pipeline of highly skilled technicians who can adapt to industry changes. Singapore's *SkillsFuture* program, which gives credits to citizens for lifelong learning, is another idea for sustainability (SkillsFuture Singapore, 2021). Malaysia's forthcoming *Pelan Induk TVET* could incorporate a similar credit system to encourage continuous skill upgrading among electronics professionals.
- **Japan's Focus on Quality and Continuous Improvement (Kaizen):** Instilling a culture of continuous improvement at all worker levels sustained Japan's manufacturing leadership. Through agencies like MPC (Malaysia Productivity Corporation), we can expand training in quality circles, problem-solving, and lean manufacturing specifically for E&E firms. This not only boosts current productivity but builds a workforce mindset geared towards long-term excellence and adaptability – a sustainable competitive trait. Many Japanese firms in Malaysia already practice this; ensuring knowledge transfer from them to local firms via supplier training programs would propagate this culture.
- **India's IT and Engineering Manpower Scaled Training:** India leveraged public-private partnerships to rapidly scale up its IT talent (through schemes like NASSCOM's training programs). For Malaysia, forming a consortium of major electronics employers to jointly develop and fund additional training institutes (similar to PSDC but perhaps virtual for nationwide reach) can sustainably ensure talent supply without entirely relying on public funding. This shared responsibility model (industry co-investing in talent) as practiced in India's software parks can be adapted for hardware/electronics.
- **Thailand's Talent Mobility Program and STEM Outreach:** Thailand has programs to place academic researchers into SMEs (Talent Mobility) and significant STEM outreach like the National Science and Technology Development Agency's initiative. Adapting these, Malaysia can formalize a **Researcher Attachment** program (where PhD holders spend time solving industry problems in companies, with government stipend support) and expand on programs like the Science Outreach under ASM (Academy of Sciences Malaysia) to groom interest from school level – making our talent strategy sustainable from primary school to post-doctorate.

- **Recommendation**: Introduce a "SkillsMalaysia" initiative targeting fields like semiconductor engineering, AI development, and advanced robotics, leveraging modular training models and partnerships with global tech firms to ensure relevance and competitiveness. Subsidize short-term certifications, especially for young professionals and mid-career workers. Highlight collaboration with international training providers to ensure global skill relevance.

Insights from Case Study 4: Talent Development Challenges
The E&E industry faces a critical shortage of engineers in specialized areas like IC design and embedded systems. With demand expected to grow by 30% annually in regions like Penang, addressing this skills gap is vital. Initiatives like the Penang Skills Development Centre's (PSDC) collaboration with industries to design curricula aligned with workforce needs provide a model for scaling up national upskilling programs.

Insights from Case Study 6: Graduate Employability
Graduate employability programs initiated by companies like Petronas and Maybank have shown how integrating corporate needs with academic curricula can improve job readiness. Scaling these efforts nationally will bridge the talent gap.

5.4.2.2 Revitalizing STEM Education and Industry-Academia Collaboration

- **Asia Context**: Vietnam's Ministry of Education collaborates with Google and Microsoft to integrate industry-relevant curricula into STEM programs (Tuong, Tran & Nguyen, 2023). Similarly, Singapore's collaboration with IBM on AI curriculum development (IBM Singapore, 2024) and Thailand's partnership with Huawei for ICT talent programs (Yang, 2024) demonstrate effective industry-academia synergies in STEM education.
- **Recommendation**: Reform Malaysia's STEM curriculum to align with industry needs. Establish innovation labs in schools and universities funded jointly by the government and private sector to nurture interest and practical skills. Suggest introducing competitions or hackathons to inspire innovation and real-world problem-solving skills among students.

Insights from Case Study 7: STEM Hubs
The establishment of regional STEM hubs in underserved areas has demonstrated success in increasing accessibility to high-quality education. Replicating such initiatives can enhance STEM talent pipelines.

5.4.3 Regulatory Excellence: Enabling Innovation and Investment

5.4.3.1 Streamlining Approvals

- **Ireland's FDI-Friendly Regulation and One-Stop Agencies:** Ireland, much like Malaysia, attracted electronics and pharma FDI through very business-friendly policies. Key was having one-stop agencies (IDA Ireland) and tax/regulatory regimes that favor high-tech investment. Malaysia already has MIDA and various incentives, but we can innovate further by offering, for instance, **R&D super-deductions** (tax deduction greater than 100% of expense) which Ireland had, or **Knowledge Development Box**-like tax rates for income from patents (to encourage local IP creation). Ensuring our regulations around IP protection, data security, etc., are world-class will also draw R&D activities here. Ireland's approach to regulator-industry collaboration (they often tweak

policies in consultation with major investors quickly) is something our Pemudah or similar bodies should emulate for agility.

- **Finland's Light-Touch Regulation for Startups:** Finland (and broadly the Nordic model) promotes innovation by keeping regulations light for new and small companies, particularly in emerging sectors. Malaysia could introduce thresholds below which certain onerous regulations don't fully kick in – e.g., a startup with <50 employees might get exemptions or simplified compliance for the first few years in aspects like reporting or certain fees. This encourages experimentation and new firm entry, fueling long-term industry renewal.
- **ASEAN Best Practices and Integration:** As ASEAN neighbors improve (Vietnam's booming electronics sector, for instance), Malaysia should not only compete but integrate. Lead in pushing for **harmonized standards and easier intra-ASEAN talent mobility** for specialists. If a Vietnamese engineer can easily take up a job in Malaysia (and vice versa) under some ASEAN talent agreement, the region's talent pool is effectively larger – benefitting all and making growth sustainable even when individual countries face shortages. Similarly, Indonesia's Online Single Submission (OSS) system has digitalized the business licensing process, significantly reducing bureaucracy (Kementerian Investasi dan Hilirisasi, 2023).
- **Recommendation**: Establish an integrated, digital platform for regulatory processes to reduce delays and improve investor confidence. Ensure harmonization across federal, state, and local government systems.

Insights from Case Study 8: Regulatory Hurdles

Case studies of delays in obtaining approvals, such as Malaysia's outdated standards for imported materials, highlight the urgent need for regulatory modernization. Establishing a transparent, digitalized system can mitigate financial losses and strengthen Malaysia's competitiveness in global supply chains.

5.4.3.2 Enhancing ESG Adoption

- **Asia Context**: Thailand's Securities and Exchange Commission (SEC) mandates ESG compliance for listed companies, driving industry-wide adoption (SEC Thailand, 2021). Singapore has implemented a carbon tax to incentivize sustainable practices in the Carbon Pricing Act 2019 (Singapore Ministry of Sustainability and the Environment, 2024), while Vietnam promotes ESG adoption through its Green Growth Strategy, aligned with UN Sustainable Development Goals (Ministry of Planning and Investment Vietnam, 2021).
- **Recommendation**: Introduce ESG incentives and mandates tailored to the electronics industry, ensuring compliance with environmental and social governance standards. Offer subsidies for green manufacturing and impose penalties for non-compliance.

Insights from Case Study 9: ESG and Green Manufacturing

Malaysia's progress in renewable energy production and green manufacturing, such as solar PV production, showcases its potential to lead ESG initiatives in electronics. Strengthening incentives for compliance can further this impact.

5.4.3.3 Promoting Adaptive Regulations

- **Asia Context**: Japan's Ministry of Economy, Trade, and Industry (METI) supports adaptive regulations for emerging technologies, such as regulatory sandboxes for fintech and AI (Ministry of Economy, Trade and Industry Japan, 2024). Similarly,

SIDEC's Selangor Accelerator Programme offers flexible regulatory guidance to startups in Malaysia (Selangor Information Technology & Digital Economy Corporation (SIDEC), 2024).

- **Recommendation**: Introduce adaptive regulations to foster innovation while maintaining oversight. Focus on developing sandboxes for key sectors such as semiconductors, fintech, and green technologies.

Table 5.4.2 Enhancing Innovation Performance (IP), Talent Management (TM), and Regulatory Environments (RE) in Asia: Best Practices and Proposed Initiatives

Category	**Subcategory**	**Examples**	**Actionable**
Innovative Performance (IP)	Expand Funding Mechanisms	A*STAR (Singapore), Penang i4.0 Seed Fund (Malaysia), MOTIE (South Korea)	Create a regional innovation fund to pool resources and support cross-border collaborations.
Innovative Performance (IP)	Innovation Hubs	Cyberjaya (Malaysia), Penang STEM, Zhongguancun Science Park (China)	Create a network of regional innovation hubs to foster collaboration and knowledge sharing.
Innovative Performance (IP)	Innovation Challenges and Competitions	Indonesia's National Innovation Competition, PISF 2024, India's Smart India Hackathon	Organize regional innovation competitions to foster collaboration and identify cutting-edge solutions to regional challenges.
Innovative Performance (IP)	Innovation Bootcamps	Thailand's DEPA bootcamps, SIDEC's Selangor Accelerator Programme, India's Atal Innovation Mission	Organize regional innovation bootcamps to provide intensive training and mentorship to startups.
Innovative Performance (IP)	National STEM Innovation Festival	Vietnam's STEM Festival, PISF 2024, India's National Science Day	Organize a regional STEM innovation festival to showcase cutting-edge research and inspire the next generation of innovators.
Regulatory Environment (RE)	One-Stop Regulatory Portal	Singapore's Business Grants Portal, InvestPenang, Invest Korea One-Stop Service Center	Develop a regional regulatory harmonization framework to reduce barriers to cross-border trade and investment.
Regulatory Environment (RE)	Digital Transformation of Regulatory Processes	Indonesia's OSS system, SIDEC's initiatives, South Korea's e-Government system	Implement a regional blockchain-based platform for secure and transparent regulatory data exchange.
Regulatory Environment (RE)	Uniform Enforcement	Singapore's regulatory bodies, Penang's regulatory bodies, Japan's METI	Create a regional regulatory cooperation forum to enhance consistency and transparency in regulatory enforcement.
Regulatory Environment (RE)	Adaptive Regulations	Malaysia's regulatory sandboxes, SIDEC's Selangor Accelerator Programme, Japan's METI	Develop a regional framework for regulatory experimentation to support the development and deployment of emerging technologies.
Regulatory Environment (RE)	Public-Private Dialogue	Philippines' Public-Private Partnership Center, InvestPenang, India's NITI Aayog	Establish a regional platform for public-private dialogue to facilitate collaboration and co-creation of policies.
Regulatory Environment (RE)	Compliance Incentives	Singapore's tax incentives, SIDEC's incentives, Japan's METI incentives	Develop a regional framework for recognizing and rewarding compliance with environmental and social standards.

Regulatory Environment (RE)	Regulatory Sandboxes	Singapore's regulatory sandbox, Japan's METI	Establish regional regulatory sandboxes to test and evaluate innovative technologies and business models.
Talent Management (TM)	Talent Exchange Programs	Thailand's Talent Mobility Program, PSDC's GDVT, Japan's JET Programme	Establish a regional talent mobility platform to facilitate seamless exchange of skilled professionals.
Talent Management (TM)	Lifelong Learning Credits	Singapore's SkillsFuture, PSDC's continuous learning programs, Japan's HRD Initiative for Asia	Develop a regional accreditation system for skills and qualifications to enhance workforce mobility and recognition.
Talent Management (TM)	STEM Education Reform	Vietnam's National STEM Program, Penang STEM's initiatives, India's Atal Innovation Mission	Establish a regional STEM education network to share best practices and develop common curricula.
Talent Management (TM)	Engineering Ambassadors Program	Thailand's Engineering Institute, Penang STEM's Chip Design Academy, South Korea's Engineers Without Borders	Launch a regional engineering ambassador program to inspire young people to pursue STEM careers.
Talent Management (TM)	National Skills Registry	Penang STEM Talent Blueprint	Create a regional skills registry to match talent with job opportunities and track workforce development trends.
Talent Management (TM)	Industry Scholarships and Apprenticeships	Singapore's SkillsFuture Work-Study Program, PSDC's scholarships, South Korea's Samsung Tech Institute	Promote regional mobility for scholarship and apprenticeship programs to enhance skills development and international experience.
Talent Management (TM)	Training and Resources	Thailand's Board of Investment, PSDC's training programs, South Korea's KOTRA	Develop a regional knowledge-sharing platform for regulatory compliance and best practices.
Talent Management (TM)	Government-Sponsored Talent Retention Incentives	Singapore's Tech.Pass program, InvestPenang's PISP, South Korea's K-Move program	Implement regional talent attraction and retention programs to compete for top talent in the global market.

5.5 Chapter Conclusion

Malaysia's journey toward becoming a global leader in the electronics industry hinges on bold and strategic initiatives. As in Figure 5.5.1, by enhancing Innovative Performance (IP) through centralized R&D ecosystems, fostering Talent Management (TM) through structured upskilling and STEM-focused programs, and refining the Regulatory Environment (RE) to align with global standards, the nation can position itself at the forefront of the global electronics ecosystem. Drawing inspiration from successful models in Asia, these actionable recommendations serve as a roadmap for sustained growth and long-term competitiveness.

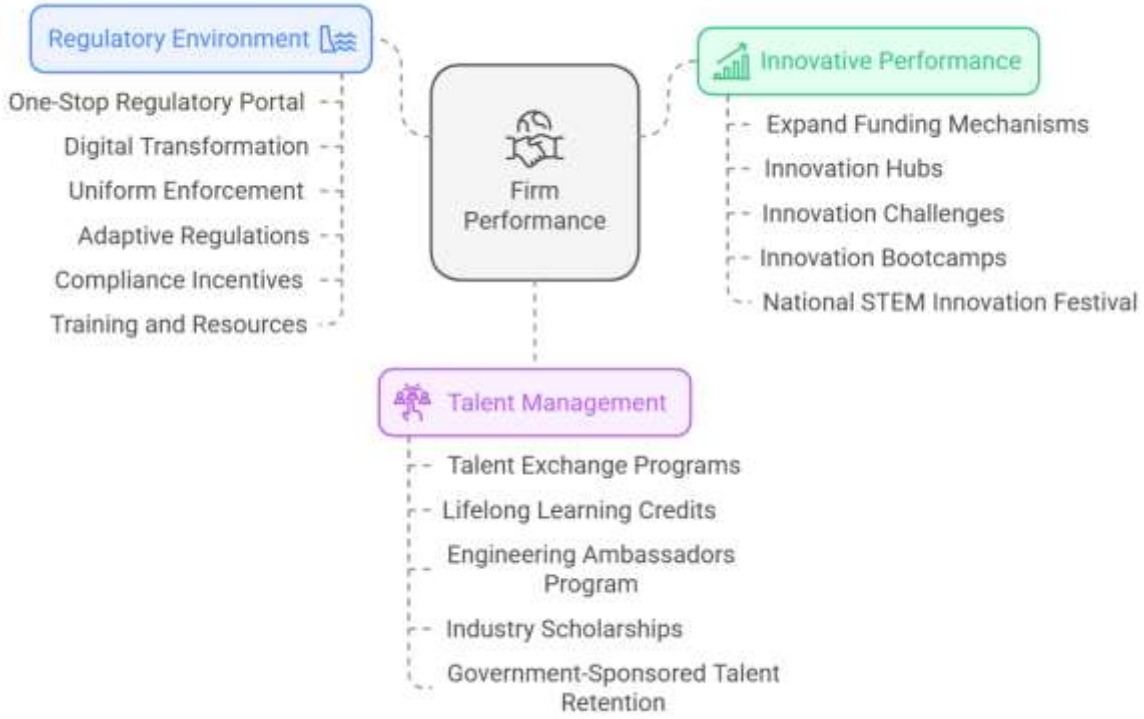


Figure 5.5.1 Summary of the actionable recommendations

Recent developments such as the RM50 million allocation for Penang's Silicon Design Initiative and the establishment of Malaysia's Semiconductor IC Design Park underscore the country's readiness to embrace this transformative journey. With effective execution of these recommendations, Malaysia can not only bolster its electronics industry but also set an example for regional innovation and excellence.

6. Quantitative Analysis of Government Interventions and Firm Performance: An RBV Approach to Malaysia's Electronics Industry

6.1 Introduction

The research design for this study thus combines exploratory qualitative analysis with quantitative testing to address the research objectives comprehensively. In the Chapter 4, qualitative methods identified and developed a research framework around key variables affecting firm performance, with particular insights specific to Malaysia's electronics industry. In this Chapter 6, quantitative methods were applied to confirm and quantify the hypothesized relationships, focusing on the role of government interventions in enhancing Innovative Performance (IP), Talent Management (TM), and Regulatory Environment (RE) as drivers of Firm Performance (FP). the analysis uses survey data collected from industry respondents to statistically evaluate the relationships inferred from theory and qualitative findings. The goal is to provide empirical evidence on the magnitude and significance of these effects, thereby lending support to the policy recommendations proposed in Chapter 5. This mixed-method approach provides a holistic analysis of how government support influences firm success from both theoretical and empirical perspectives, grounded in the unique context of Malaysia.

6.2 Research Design

This study employs a **mixed-method sequential explanatory design** combining **qualitative** and **quantitative approaches** to investigate the impact of government interventions on firm performance within Malaysia's electronics industry. The research design is structured in two sequential phases, beginning with a qualitative exploration on the case studies to develop a theoretical framework, followed by a quantitative approach to empirically test and validate the proposed relationships.

6.2.1 Qualitative Research Phase

As detailed in Chapter 4, the qualitative phase of this study explored key factors influencing firm performance through case studies in Malaysia's electronics sector. This exploratory phase aimed to provide deeper insights into industry-specific challenges, uncovering three primary government-supported drivers: Innovative Performance (IP), Talent Management (TM), and the Regulatory Environment (RE). These insights informed the research framework and clarified how government interventions are perceived in terms of operational impact and relevance to performance.

This qualitative phase is classified as exploratory research, providing preliminary insights into underlying issues and relationships among variables. The findings shaped the hypothesized framework by identifying how government interventions in IP, TM, and RE could potentially impact firm performance, which the quantitative phase seeks to confirm and quantify.

6.2.2 Quantitative Research Phase

Following the qualitative phase, this study adopts a quantitative research design to empirically test the hypothesized relationships within the research framework. This phase is intended to statistically analyze the strength and direction of the relationships among variables, thereby providing robust evidence for or against the hypotheses derived from qualitative findings.

In this quantitative phase, explanatory research was conducted to test causal relationships between government interventions and firm performance, focusing on how IP, TM, and RE that each influenced by government support, affect performance outcomes. Notably, the constructs for IP, TM, and RE were newly developed for this study, emphasizing exploratory elements to

refine these constructs. A structured questionnaire was distributed to senior managers and decision-makers in Malaysia's electronics firms, whose responses were analysed to assess the impact of the independent variables (IP, TM, RE) on the dependent variable (FP). This dual approach allows for a comprehensive exploration of these constructs while validating the relevance of government support in the Malaysian electronics context.

6.2.3 Integration of Qualitative and Quantitative Approaches

This mixed-method design leverages the strengths of both qualitative and quantitative research (See Figure 6.2.1). The qualitative phase provides contextually grounded insights, while the quantitative phase statistically validates these factors, ensuring the findings are both grounded in real-world industry perspectives and supported by empirical data (See Figure 6.2.2). By applying the Resource-Based View (RBV), this framework emphasizes firm-specific resources and capabilities that can be strengthened by government interventions, positioning them as competitive advantages within the industry.

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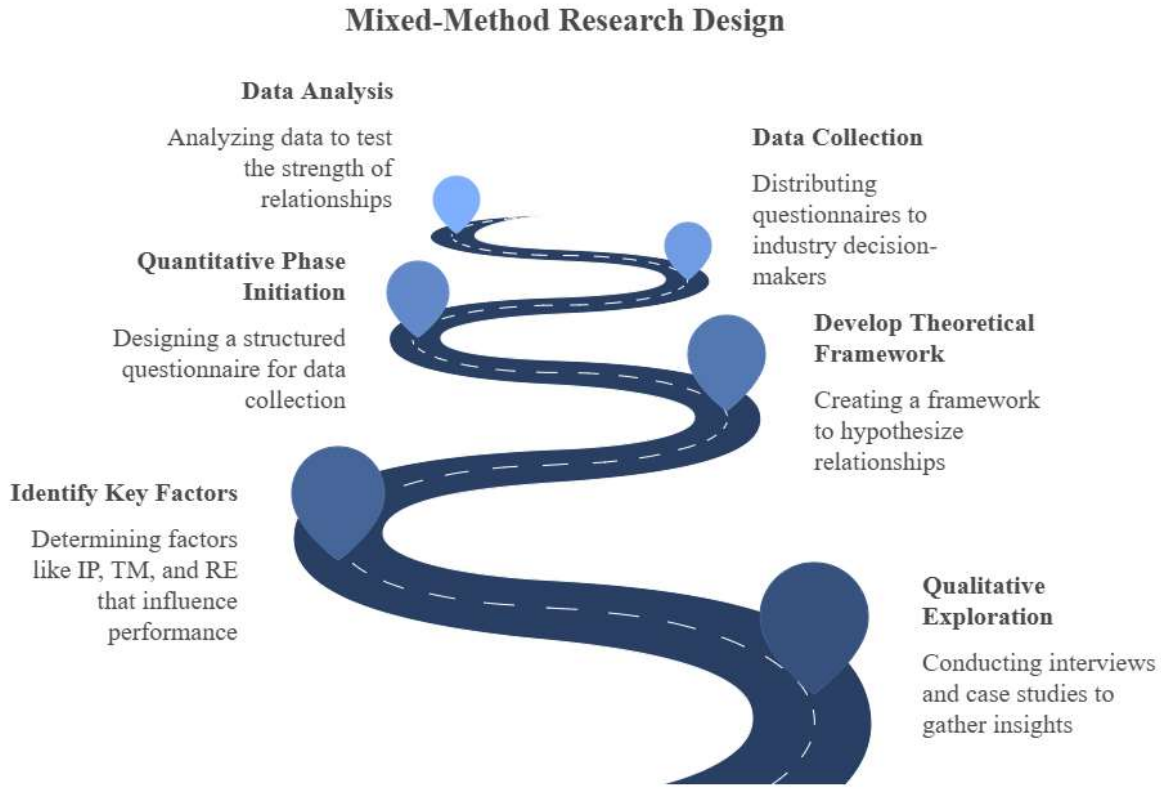


Figure 6.2.1: Mixed-method design **weights the strengths of both qualitative and quantitative research.**

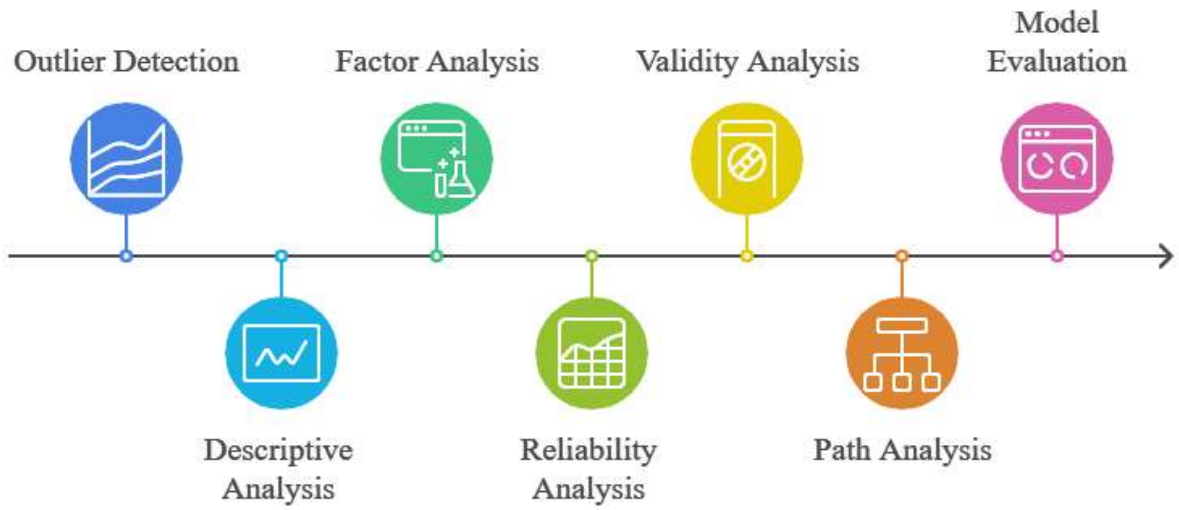


Figure 6.2.2: The typical quantitative analysis process.

6.3 Overview of RBV and its relevance to firm performance

The RBV framework, a cornerstone in strategic management, posits that a firm's internal resources and capabilities are the primary drivers of competitive advantage and performance. Introduced by Wernerfelt (1984) and developed further by Barney (1991), the RBV highlights that resources that are valuable, rare, inimitable, and non-substitutable (VRIN) can provide sustainable competitive advantages.

The RBV framework is particularly relevant to firm performance (FP) as it shifts the focus from external market conditions to internal firm-specific factors. By emphasizing the strategic importance of internal resources, the RBV provides a robust theoretical foundation for understanding how firms can achieve superior performance. Resources such as proprietary technology, skilled labour, strong brand reputation, and efficient processes are seen as crucial assets that firms can leverage to gain a competitive edge (Barney, 1991). Furthermore, RBV argues that firms with superior resources are better equipped to formulate and implement strategies that outperform their competitors, thereby achieving higher levels of firm performance.

Firm performance (FP) is a multi-dimensional construct that encompasses various indicators of a firm's success, including financial metrics such as profitability, return on assets (ROA), and sales growth, as well as non-financial metrics like market share, customer satisfaction, and operational efficiency. The RBV framework is particularly relevant in linking internal resources to these performance metrics, as it posits that the effective management and deployment of a firm's unique resources directly contribute to enhanced FP.

In the context of Malaysia's electronics sector, the RBV shifts focus from external market conditions to internal firm-specific factors supported by government policies, underscoring the strategic importance of firm-specific resources like IP and TM, and while RE is treated as an influential factor that can enhance or impede the utilization of those capabilities. Firms that excel in these areas are more likely to achieve sustainable growth, increased profitability, and stronger market positioning. For instance, a firm that invests in cutting-edge R&D and cultivates a skilled workforce can differentiate itself through innovative products and efficient

operations, leading to higher profitability, market share, and customer satisfaction (Shamsuddin, 2014; Chin, 2019).

Moreover, the RBV framework underscores the importance of aligning government policies with the internal capabilities of firms. Government interventions that support innovation, talent development, and regulatory compliance can enhance these internal resources, thereby improving firm performance. By creating a conducive environment for the growth and development of these resources, the government can help firms in the electronics sector to achieve sustainable competitive advantages.

Overall, the RBV framework provides a valuable lens for analysing the role of internal resources in driving firm performance (see Figure 6.3.1). Its application to the Malaysian electronics sector highlights the critical importance of focusing on internal strengths to achieve long-term success in a highly competitive industry. This study hypothesizes that government interventions in these areas can enhance firm performance by augmenting the VRIN characteristics of these resources, thus aligning with RBV's focus on leveraging internal strengths.

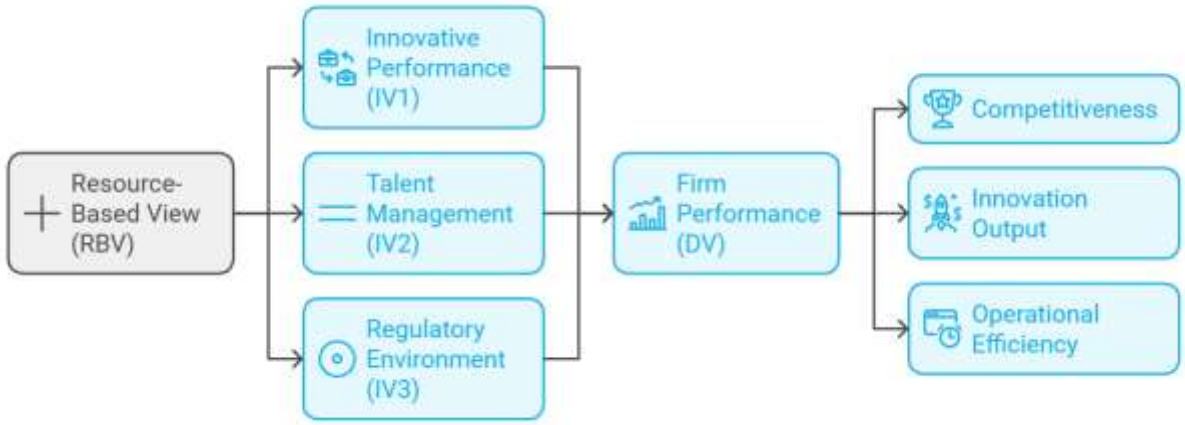


Figure 6.3.1: Resource-Based Views drives the Firm Performance that results a better competitiveness, innovative output and operational efficiency.

6.4 Previous studies on IP, TM, and RE in the context of firm performance

The section reviews existing literature on IP, TM, and RE as critical factors in firm performance, highlighting findings from both global and Malaysian contexts. This review identifies a significant gap in the literature, as most prior studies examined these factors individually rather than in combination. This study addresses this gap by analysing the potential synergies and cumulative effects of IP, TM, and RE on FP, particularly under the influence of government support. Additionally, the literature review emphasizes the need for more localized research within Southeast Asia to address the unique regulatory and economic conditions in Malaysia.

6.4.1 Innovative Performance (IP) in the context of firm performance

Innovative Performance (IP) has been widely recognized as a critical driver of firm performance across various industries (see Figure 6.4.1). Numerous studies have demonstrated that firms that prioritize innovation tend to outperform their competitors in key performance metrics such as profitability, market share, and growth. Innovation enables firms to introduce

new products, improve processes, and adapt to changing market conditions, which in turn leads to competitive advantages and superior firm performance (FP).

For instance, a study by Zahra and Das (1993) established that innovation, particularly in product development, plays a crucial role in enhancing firm performance, especially in dynamic and competitive environments. The results supported the importance of innovation strategy as a determinant of company financial performance.

One seminal study by Calantone, Cavusgil, and Zhao (2002) found that firms with a strong orientation towards learning and innovation achieved superior performance in terms of market share and profitability. Their research demonstrated that a firm's ability to innovate, particularly in rapidly changing markets, is a significant predictor of its overall success.

Another important study by Hult, Hurley, and Knight (2004) explored the impact of innovation orientation on their business performance or firm performance. They found that firms with a proactive approach to innovation, characterized by a commitment to R&D and a culture that supports creative problem-solving, were more likely to achieve higher levels of financial performance, including increased profitability and market growth. This finding is echoed by research from Rosenbusch, Brinckmann, and Bausch (2011), who conducted a meta-analysis of small and medium-sized enterprises (SMEs) and found a consistent positive relationship between innovation and firm performance across different industries and regions.

Similarly, the work of Artz et al. (2010) emphasized the long-term benefits of innovation on firm performance. Their research showed that sustained innovation efforts, measured by R&D intensity and patent activity in their paper, are strongly associated with higher levels of firm performance over time. They argued that innovation not only contributes to immediate financial gains but also helps build a firm's reputation, strengthens customer loyalty, and enhances operational efficiency, all of which are crucial for sustaining competitive advantage in the long run.

Lastly, the research by Jiménez-Jiménez and Sanz-Valle (2011) focused on the role of innovation in achieving sustained competitive advantage. They found that innovation not only enhances immediate firm performance but also contributes to long-term success by enabling firms to adapt to market changes and maintain their competitive edge over time.

These studies collectively underscore the vital role that Innovative Performance plays in driving firm success. In the context of Malaysia's electronics industry, where competition is fierce and technological advancements are rapid, fostering IP is crucial for firms to achieve and sustain superior performance outcomes.

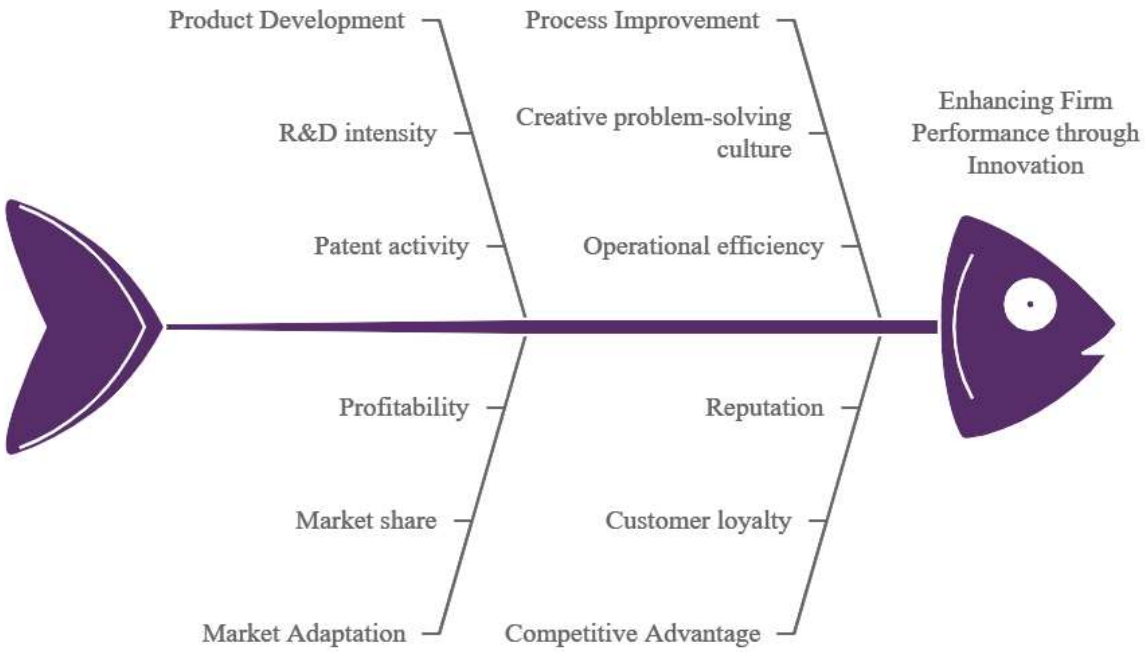


Figure 6.4.1 Impact of Innovation Performance to Firm Performance

6.4.2 Talent Management (TM) in the context of firm performance

Talent Management (TM) has emerged as a crucial strategic function within organizations, significantly impacting firm performance. TM encompasses a wide range of activities, including the recruitment, development, retention, and engagement of high-performing employees (Figure 6.4.2). Numerous studies have demonstrated that effective TM practices are closely linked to various dimensions of firm performance, such as productivity, profitability, innovation, and employee satisfaction.

One key study by Collings and Mellahi (2009) highlighted the strategic importance of TM in enhancing organizational performance. They argued that by identifying and managing key talents, those employees who contribute disproportionately to organizational success, firms can achieve sustained competitive advantages. Their research found that organizations with robust TM practices tend to outperform their peers in both financial and non-financial performance metrics.

Another important contribution by Huselid, Beatty, and Becker (2005) emphasized the role of TM in aligning human capital with the strategic goals of the organization. Their study demonstrated that firms with superior TM systems, which effectively manage their talent pool, exhibit higher levels of firm performance, including increased productivity and profitability. They further argued that TM should be integrated into the overall strategic management process to maximize its impact on firm outcomes.

A study by Thunnissen, Boselie, and Fruytier (2013) expanded on the link between TM and firm performance by exploring the role of TM in fostering innovation and creativity. They found that firms with effective TM practices, particularly those that emphasize employee development and engagement, are more likely to foster an innovative culture that drives business success. Their findings suggest that TM is not only about managing talent but also about creating an environment where talent can thrive and contribute to the firm's innovation capabilities.

Additionally, the research by Lewis and Heckman (2006) provided a comprehensive review of TM practices and their impact on firm performance. They identified key TM practices, such as talent acquisition, development, and retention, and linked them to improved organizational outcomes, including better financial performance, higher employee morale, and reduced turnover rates. Their study underscored the importance of viewing TM as a holistic process that integrates various HR functions to drive firm performance.

Furthermore, the study by Cappelli (2008) examined the implications of TM on organizational agility and adaptability. He found that firms with well-developed TM strategies are better equipped to respond to market changes and challenges, leading to superior performance. Cappelli's research suggested that TM practices that focus on flexibility and continuous development are particularly effective in enhancing firm resilience and long-term success.

Meyers and van Woerkom (2014) also contributed to the literature by exploring the concept of inclusive TM, which emphasizes the development of all employees rather than focusing solely on high potentials. Their study showed that firms adopting an inclusive TM approach tend to experience better overall performance, as this approach fosters a more engaged and motivated workforce, leading to higher levels of productivity and employee satisfaction.

A study by Gelens et al. (2013) explored the relationship between TM and employee performance. They found that firms with strong TM practices not only attract top talent but also enhance the performance of existing employees through targeted development programs and performance management systems. This, in turn, leads to improved firm performance, particularly in areas such as customer satisfaction and operational efficiency.

Finally, the research by McDonnell, Lamare, Gunnigle, and Lavelle (2010) focused on the global context, examining the role of TM in multinational corporations (MNCs). Their study found that MNCs with effective TM practices are more successful in managing cross-cultural teams and achieving consistent performance across different geographical locations. This highlights the importance of TM in maintaining firm performance in a globalized business environment.

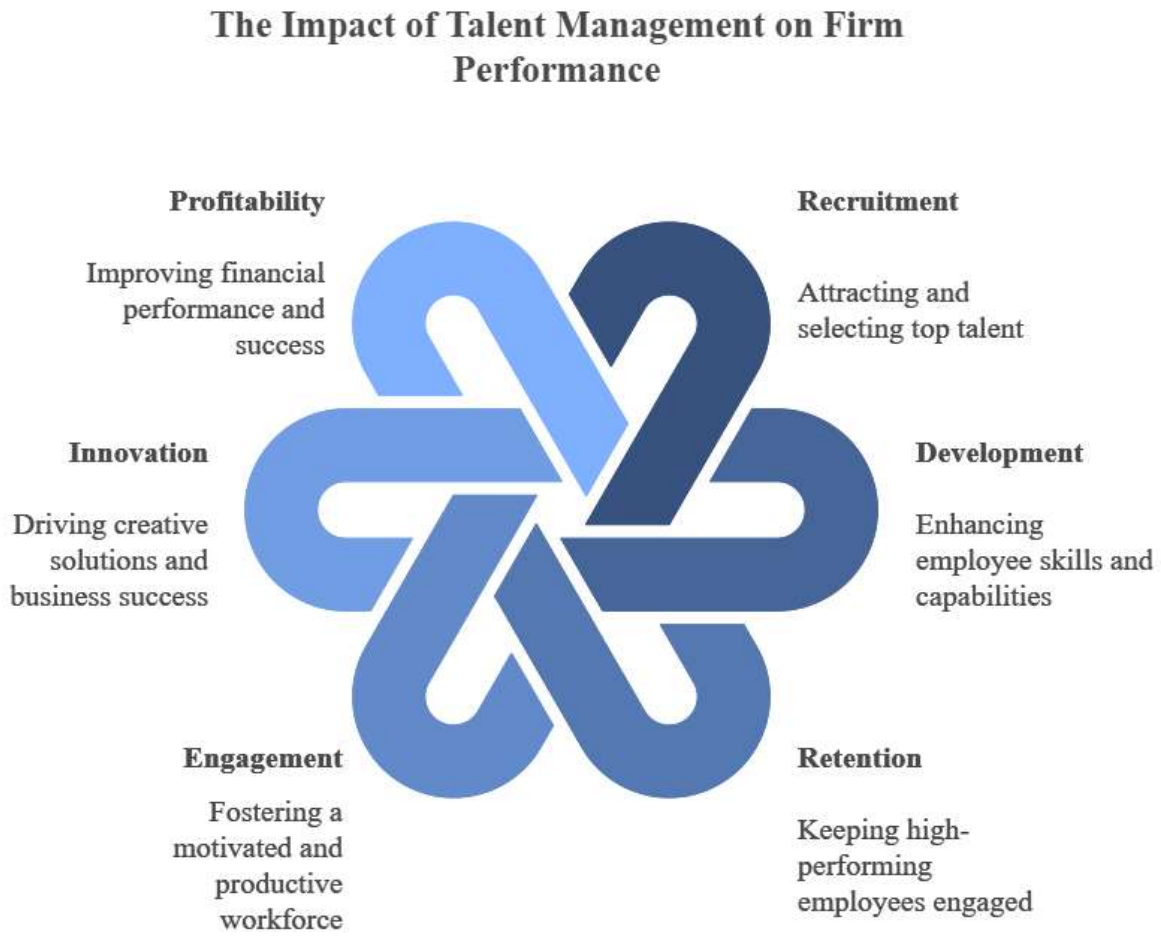


Figure 6.4.2 Impact of Talent Management to Firm Performance

6.4.3 Regulatory Environment (RE) in the context of firm performance

The Regulatory Environment (RE) is a critical factor that influences firm performance across various industries. It encompasses the laws, regulations, and policies that govern business operations, ensuring fair competition, protecting consumer rights, and maintaining public safety. A supportive regulatory environment can enhance firm supply chain efficiencies by providing stability, reducing uncertainty, and facilitating business operations, while a burdensome or unclear regulatory framework can hinder firm growth and competitiveness (see Figure 6.4.3).

Several studies have explored the impact of RE on firm performance, highlighting the significant role that regulations play in shaping business outcomes. For example, Djankov, McLiesh, and Ramalho (2006) conducted a comprehensive study across multiple countries and found that a more business-friendly regulatory environment, characterized by streamlined procedures and lower compliance costs, was positively associated with higher firm performance, particularly in terms of productivity and profitability.

Similarly, a study by Ayyagari, Demirgüç-Kunt, and Maksimovic (2008) emphasized the importance of regulatory quality in fostering firm growth. Their research, which focused on developing economies, revealed that firms operating in environments with clear and efficiently enforced regulations were more likely to experience higher growth rates, increased investment, and improved financial performance. This finding underscores the critical role of an effective regulatory framework in supporting business success.

Another significant study by Beck, Demirgüç-Kunt, and Maksimovic (2005) examined the relationship between legal and regulatory systems and firm performance in developing countries. They found that firms in countries with stronger legal protections and more effective regulatory enforcement reported better access to finance, higher growth, and greater operational efficiency, highlighting the importance of a robust regulatory environment in supporting firm development.

Further research by La Porta, Lopez-de-Silanes, and Shleifer (2008) provided evidence that countries with better-developed regulatory frameworks tend to have more vibrant and competitive markets, which in turn leads to improved firm performance. Their study suggested that regulations that promote transparency, reduce corruption, and protect property rights are particularly beneficial for firm success.

Another relevant study by Klapper, Laeven, and Rajan (2006) analyzed the impact of entry regulations on firm performance. Their findings revealed that lower entry barriers and streamlined regulatory processes were associated with higher levels of entrepreneurship, firm entry, and overall economic growth, suggesting that regulatory reforms aimed at easing market entry can significantly boost firm performance.



Figure 6.4.3 Factor influencing Firm Performance

6.5 Identified gaps in the current literature

While substantial research has been conducted on the relationships between Innovative Performance (IP), Talent Management (TM), the Regulatory Environment (RE), and firm performance, several gaps remain that warrant further investigation. These gaps present opportunities for future research to deepen the understanding of how these factors interact and influence firm performance, particularly in specific contexts such as Malaysia's electronics sector (see Figure 6.5.1).

One significant gap in the literature is the limited exploration of the combined effects of IP, TM, and RE on firm performance. Most studies tend to examine these factors in isolation, failing to account for the potential synergies or conflicts that may arise when they are considered together. For instance, while research by Calantone, Cavusgil, and Zhao (2002) and Zahra and Das (1993) has established the importance of innovation, and studies by Collings and Mellahi (2009) and Huselid, Beatty, and Becker (2005) have highlighted the critical role of talent management, there is a lack of comprehensive studies that analyze how these elements interact with regulatory environments to impact firm performance holistically.

Another gap is the contextual specificity of existing studies. Much of the research has been conducted in Western contexts, particularly in developed economies, which may limit the applicability of findings to emerging markets like Malaysia. Studies by Djankov, McLiesh, and Ramalho (2006) and La Porta, Lopez-de-Silanes, and Shleifer (2008), for example, focus on broader international samples or specific regions, but often overlook the unique regulatory, cultural, and economic conditions of Southeast Asian markets. There is a need for more localized research that considers how the specific regulatory frameworks, talent pools, and innovation ecosystems in Malaysia affect firm performance.

Moreover, the dynamic nature of the regulatory environment is often underexplored. Regulatory changes can have both immediate and long-term impacts on firm performance, yet many studies, such as those by Tan and Low (2017) and Beck, Demirgüç-Kunt, and Maksimovic (2005), primarily focus on static analyses. There is a need for longitudinal studies that examine how changes in regulations over time influence firm outcomes, particularly in rapidly evolving industries like electronics.

Additionally, there is a scarcity of research on how firms in different stages of growth, startups, SMEs, and large corporations which differ in their responses to IP, TM, and RE. Studies like those by Lewis and Heckman (2006) and Klapper, Laeven, and Rajan (2006) generally treat firms as a homogenous group, without accounting for the varying challenges and opportunities that firms at different stages face. Understanding these differences is crucial for developing tailored strategies that can enhance firm performance across the board.

Another gap is the focus on quantitative metrics of firm performance, such as profitability and market share, often at the expense of qualitative outcomes like employee satisfaction, organizational culture, and long-term sustainability. While studies by Hult, Hurley, and Knight (2004) and Meyers and van Woerkom (2014) emphasize the importance of innovation and talent management, they often rely on traditional performance indicators, leaving out broader, qualitative aspects that are equally important in assessing firm success.

Furthermore, the role of government support in facilitating the effective implementation of IP, TM, and RE practices is often underrepresented in the literature. While McDonnell, Lamare, Gunnigle, and Lavelle (2010) acknowledges the importance of regulatory frameworks, there is limited discussion on how government interventions can be optimized to support firm performance. Thus, this gap suggests a need for research that explores the effectiveness of different types of government support in various regulatory and market contexts.

Lastly, there is a gap in understanding the role of digital transformation and how it intersects with IP, TM, and RE. The rise of digital technologies has transformed how firms innovate, manage talent, and navigate regulatory environments, yet many studies, such as those by Thunnissen, Boselie, and Fruytier (2013), do not fully account for these changes. Research that

integrates digital transformation into the analysis of IP, TM, and RE could provide valuable insights into the evolving landscape of firm performance.

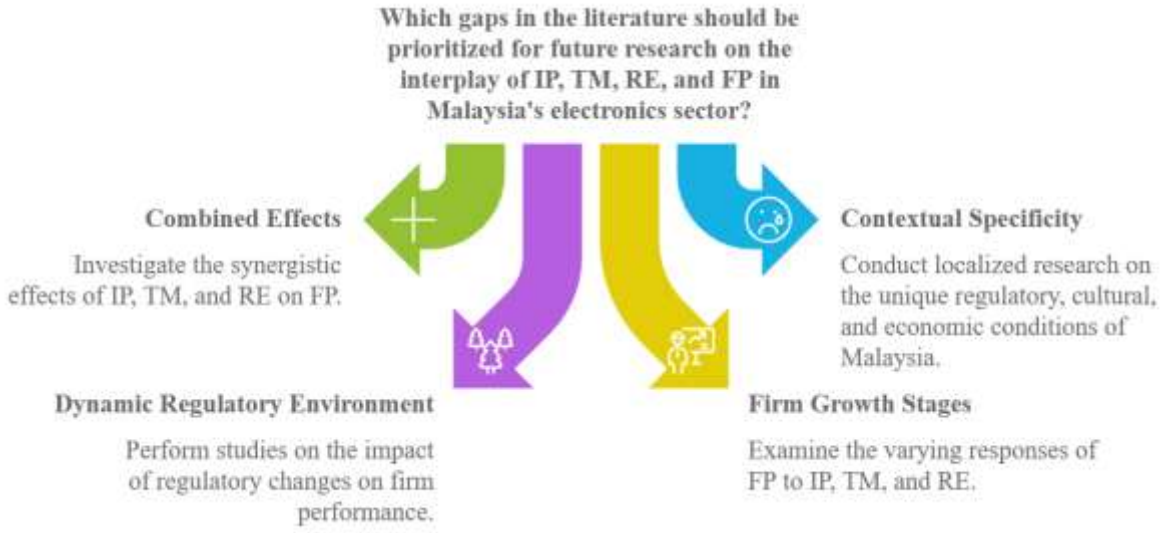


Figure 6.5.1: The gaps present opportunities for the research to deepen the understanding of how these factors interact and influence firm performance, particularly in specific contexts such as Malaysia's electronics sector

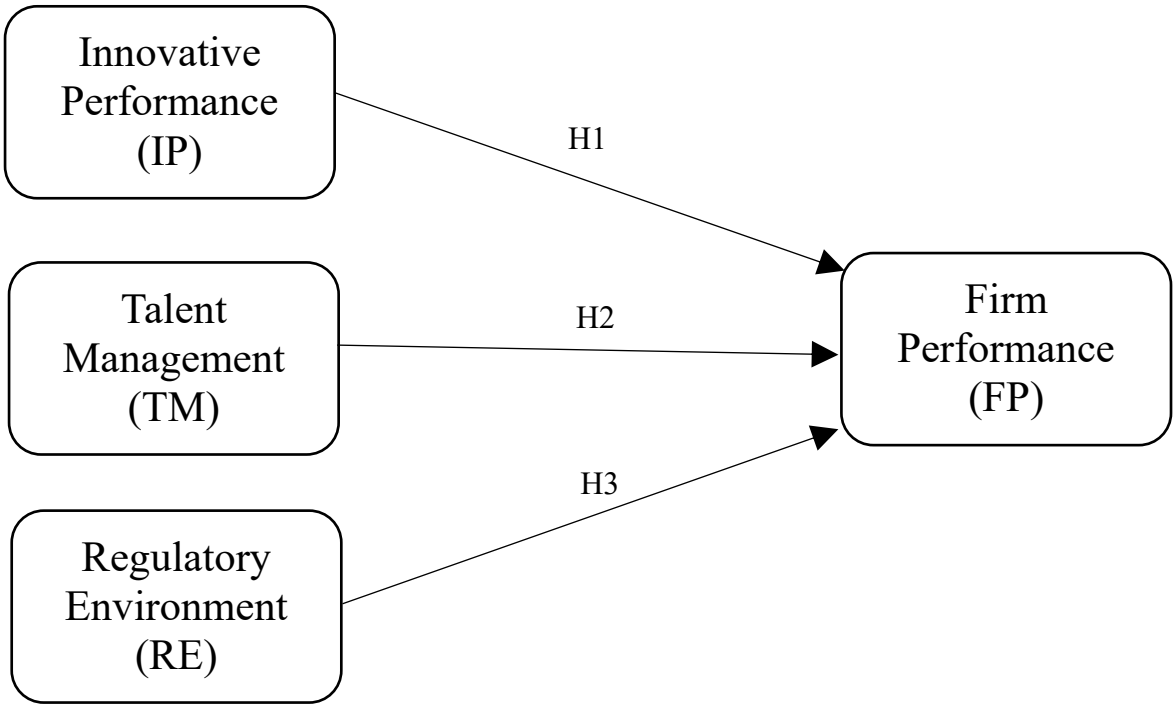
6.6 Hypotheses of the Research Framework

Based on the identified research gaps, this section outlines the hypotheses that explore the essential role of government in enhancing firm performance within Malaysia's electronics industry. These hypotheses are grounded in the RBV and supported by empirical evidence from prior studies, as well as the qualitative findings from Chapter 4. By focusing on three key factors: **Innovative Performance, Talent Management, and the Regulatory Environment,** the hypotheses aim to demonstrate how government actions can positively influence these variables. Specifically, the research suggests that government support, whether through **financial incentives, education programs, or regulatory reforms**, can amplify the impact of these factors on firm success, driving greater competitiveness and growth within the industry.

1. **H1: The Role of Government in Innovative Performance positively affects Firm Performance.**
    - Government support, such as **grants, subsidies, and incentives for R&D and innovation**, can enhance the positive impact of innovative performance on firm outcomes. This support enables firms to accelerate the introduction of new products to the market, thereby improving overall performance.
2. **H2: The Role of Government in Talent Management positively affects Firm Performance.**
    - Government initiatives, including **education programs, skills training, and policies designed to attract skilled labour**, can strengthen the effectiveness of talent management strategies. This, in turn, leads to enhanced firm performance through the development of a more capable and competitive workforce.
3. **H3: The Role of Government in the Regulatory Environment positively affects Firm Performance.**
    - Government efforts to **simplify regulations, improve policy transparency, and establish legal frameworks for emerging technologies** can positively

influence how firms navigate regulatory environments. This fosters compliance, supports business growth, and ultimately enhances firm performance.

In conclusion, the proposed hypotheses underscore the pivotal role that government interventions can play in improving firm performance within Malaysia's electronics industry. By supporting **innovation**, fostering **talent development**, and cultivating a favourable **regulatory environment**, government actions serve as key enablers of business growth and competitiveness. In Figure 6.6.1, the hypotheses suggest that a well-coordinated partnership between industry and government can help firms **overcome challenges, seize opportunities**, and achieve sustained success. Further research and analysis will provide deeper insights into the effectiveness of these interventions, validating the critical role of government in shaping firm performance.



6.6.1: Hypotheses of the Research Framework

6.7 Data collection methods, sampling technique and participant demographics

A sample represents a subset of a population, and determining an appropriate sample size is fundamental to research because it enables researchers to generalize findings to the broader population of interest (Sekaran & Bougie, 2016). Sampling is especially essential when studying an entire population is impractical. Constraints such as limited time, budget, and the risk of low response rates make it challenging to conduct in-depth analyses of every individual in the population. Selecting the right sample size and respondents is therefore critical for efficient and effective research planning.

Sampling offers several advantages, including reduced costs and faster data collection, which can yield accurate and reliable results. A well-chosen sample allows researchers to draw

meaningful generalizations about the broader population, thereby enhancing the validity of study findings (Sekaran, 2014).

This study employs a census approach within a defined subset of the population: managers and decision-makers in Malaysia's electronics firms who are identifiable through the IEM membership database. We filtered the IEM list to isolate this demographic and invited all eligible individuals. However, the number of the total invitee from IEM is not disclosed to the research. While this approach enhances coverage and representativeness within the targeted subset, it does not constitute a census of the entire Malaysian E&E industry.

The survey was administered via Google Forms, enabling respondents to complete it at their convenience. Invitees could also forward the link to other relevant decision-makers, allowing additional eligible participants to respond. On June 30, 2023, invitees received the survey link accompanied by an invitation letter on IEM letterhead that outlined the study's scope and objectives. The letter indicated a completion time of approximately 10–15 minutes and stated that data would be used solely for preparing a position paper. A two-month window was provided for submissions via Google Forms. Participants gave informed consent via an invitation letter; participation was voluntary and anonymous. Data were de-identified, stored securely, and handled under institutional guidelines and PDPA 2010.

In total, 71 complete responses were received. While modest, this response level is typical for executive/industry surveys in the Malaysian context, where organizational gatekeeping and survey fatigue are common. Nevertheless, the realized sample likely over-represents IEM-affiliated firms and managers, which may differ from non-affiliated firms in engagement, size, or capabilities. Accordingly, findings should be interpreted as indicative of IEM-affiliated E&E firms rather than statistically generalizable to the full population of Malaysian electronics firms. We report full descriptives to aid assessment of external validity and encourage cautious extrapolation.

In summary, conducting a census within this targeted subset ensures that perspectives from all available IEM-identified decision-makers are incorporated, improving the study's relevance to this segment and directly informing the research questions.

6.8 Sample Size and unit of analysis

Selecting an appropriate sample is a critical step in research. The sample size can be determined through statistical methods or by applying general rules of thumb (Aaker, Kumar, & Day, 2016; Tashakkori & Teddlie, 2010). Gathering data from an entire population is often impractical due to constraints such as time, costs, and limited research resources. Therefore, choosing the right sample size from the target population is essential to achieving consistent and reliable results (Sekaran & Bougie, 2016).

For statistical analysis, Hair et al. (2011) recommend a sample size of 10–20 times the number of variables involved. Based on this guideline, a sample size of approximately 40–80 respondents is deemed sufficient for this study with four variables, ensuring robust representation while balancing practical considerations in data collection.

The unit of analysis in this study is the individual managers and decision-makers within Malaysia's electronics firms. Since the research focuses on understanding how government interventions impact firm performance in areas such as Innovative Performance (IP), Talent

Management (TM), and the Regulatory Environment (RE), the insights from these managers and decision-makers are critical. Their involvement in organizational decision-making and strategic implementations makes them ideal sources of data for examining firm performance outcomes in this context.

6.9 Questionnaire

A questionnaire is an efficient method for data collection, designed to capture variable information through respondents' feedback on their levels of agreement, disagreement, satisfaction, or dissatisfaction. Questionnaires are typically categorized into three types: dichotomous, open-ended, and close-ended. Respondents provide subjective and objective impressions on each item associated with the variables under study.

The items from the IP, TM and RE exploratory constructs used in this research was developed newly while FP matured construct was adapted from previous studies to ensure relevance and reliability. It consists of 14 demographic questions and 37 items related to the main variables. The measurement includes seven items for Innovative Performance (IP), eight items each for Talent Management (TM) and the Regulatory Environment (RE), and 14 items to assess Firm Performance (FP). The questionnaire was prepared in English.

6.10 Operationalization of the Variables

Operational definitions translate abstract concepts into specific, measurable elements, forming a foundation for systematic observation and analysis (Blumberg et al., 2014; Sekaran, 2014). In this study, operationalization aligns variables with measurable dimensions, facilitating clear, consistent, and replicable research outcomes (Sekaran & Bougie, 2016). The process involves defining constructs, determining measurement items, and designing response formats to capture quantifiable data (see Figure 6.10.1).

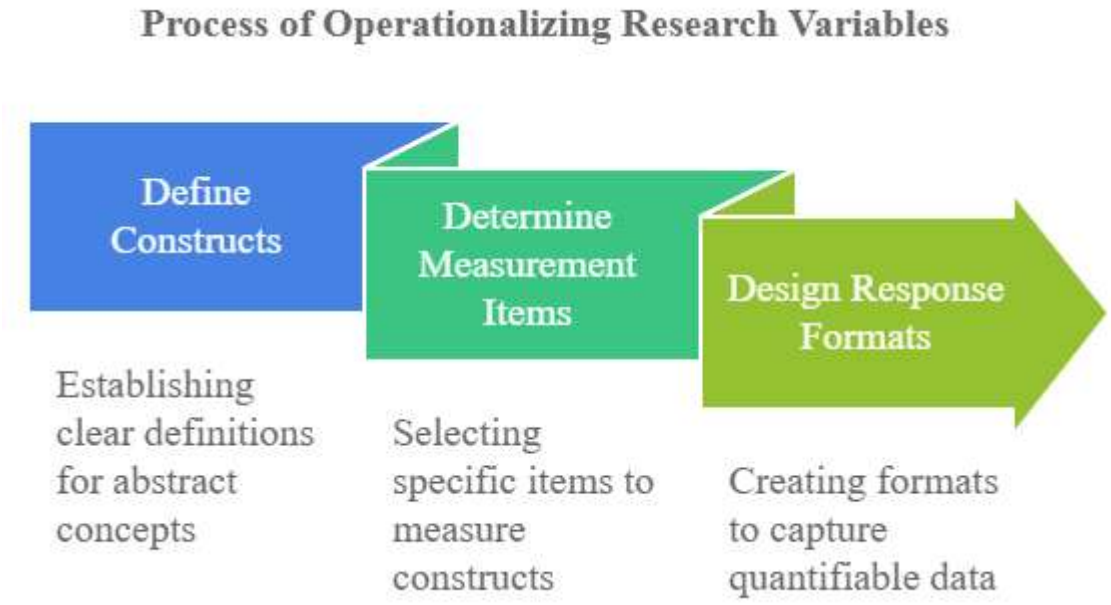


Figure 6.10.1: Process of Operationalization of the Variables

Following the establishment of the research framework, four main constructs were operationalized: IP, TM, RE, and FP. The constructs for IP, TM, and RE are newly developed to capture unique aspects of government interventions within the industry, while the FP construct was adapted from validated scales in prior studies to ensure relevance and reliability. This combination of exploratory and established constructs allows for a robust examination of the relationships between government support and firm performance, ensuring that both new insights and reliable measures are incorporated into the analysis.

Key Constructs and Measurement Approach:
Each construct is measured through specific items tailored to the Malaysian context, drawing from RBV theory and expert validation. This operationalization facilitates a clear analysis of how government interventions support these constructs in enhancing FP.

Innovative Performance (IP): This variable measures a firm's technological competitiveness, supported by government initiatives. It includes aspects such as R&D intensity, product innovation, and the adoption of advanced technologies. Items are measured on a seven-point Likert scale from 1 (strongly disagree) to 7 (strongly agree).

Table 6.10.1: Innovative Performance Items

Item Code	Item
IP1	The Government should encourage our industry to generate new innovations and ideas to enhance our company's performance.
IP2	The Government should provide guidance and assistance to adopt and improve new methods and technologies when conventional methods are insufficient in solving a problem.
IP3	The Government should provide adequate incentives and policies to promote research and development in our company.
IP4	The Government should encourage the adoption of advanced technologies to be implemented in our company.
IP5	The Government should provide an adequate ecosystem to encourage collaboration to promote innovation and creativity.
IP6	With the assistance from the Government, our company has developed new management approaches related to technology and innovation.
IP7	Compared to other countries, our Government should provide greater encouragement for our company to introduce new products into the market.

Talent Management (TM): This construct assesses the effectiveness of government-driven talent management initiatives, focusing on talent acquisition, retention, development, and career management. The items were developed to capture perceptions of government's role in supporting a robust talent ecosystem for sustained organizational outcomes.

Table 6.10.2: Talent Management Items

Item Code	Item
TM1	Our company actively engages with the Government and participates in its talent initiatives.
TM2	Our company utilizes Government policies to attract, retain, develop and manage our talents.
TM3	Our company values the Government's talent search portal for selecting experienced, qualified, and skilled employees with potential expertise.
TM4	The Government should portray a positive image and environment of our country to attract and retain foreign and local talent.
TM5	The Government should offer attractive non-monetary rewards to employers such as employer branding.
TM6	The Government should provide subsidies and incentives to employers who continuously acquire new knowledge and skills, and master new ways of doing things.
TM7	The Government should promote lifelong learning and upskilling among employees, encouraging them to acquire new knowledge and skills.
TM8	The Government should provide and support the development of STEM education for students from a young age.

Regulatory Environment (RE): Defined as the laws, rules, and regulations that influence business operations, this construct examines the perceived effectiveness, consistency, and transparency of regulatory frameworks. The items assess firms' perceptions of regulatory support in achieving compliance and competitive advantage.

Table 6.10.3: Regulatory Environment Items

Item Code	Item
RE1	The Government should regularly review and update its regulatory framework to ensure it stays up to date.
RE2	The Government should establish a one-stop center to facilitate industry compliance with regulations.
RE3	Our company believes that effective laws and execution are in place to combat business-related crimes.
RE4	Our company believes that effective laws are in place to protect intellectual property rights.
RE5	Our company believes that effective procedures and applications are in place for importing foreign labour.
RE6	Our company believes that effective procedures and applications are in place for obtaining environmental-related licenses and permits.
RE7	Our company believes that the legal environment in the country is conducive to doing business.

RE8	Our company believes that the presence of effective tax laws is crucial to ensure fairness in import and export taxation practices.

Firm Performance (FP): This variable captures a company's operational outcomes, supported by government policies, with a focus on profitability, market share, labour productivity, customer satisfaction, and other performance metrics. To measure firm performance, fourteen items adapted from prior studies (Mohd Rosli, Kuswantoro, & Che Omar, 2012; Shamsuddin, 2014; Chin, 2018) were included. The construct has demonstrated high reliability, with a Cronbach's alpha value of 0.953 (Chin, 2018), indicating strong internal consistency.

Table 6.10.4: Firm Performance Items

Item Code	Item
FP1	Thanks to the Government's business-friendly policies, my company has increased its market share.
FP2	Thanks to the Government's business-friendly policies, my company has increased labour productivity.
FP3	Thanks to the Government's business-friendly policies, my company has increased the level of customer satisfaction.
FP4	Thanks to the Government's business-friendly policies, my company has increased the overall financial performance.
FP5	Thanks to the Government's business-friendly policies, my company has increased in business expansions.
FP6	Thanks to the Government's business-friendly policies, my company has increased the high value added jobscopes.
FP7	Thanks to the Government's business-friendly policies, my company is able to retain our talent to high value added jobscopes.
FP8	Thanks to the Government's business-friendly policies, my company is able to hire high skilled talents to meet high value added jobscope requirement.
FP9	Thanks to the Government's business-friendly policies, my company is able to create a competitive advantage in the high value technology jobscope.
FP10	Thanks to the Government's business-friendly policies, my company is able to create competitive advantage and ease of doing business.
FP11	Thanks to the Government's business-friendly policies, my company has increased in employee's job satisfaction, morale and motivation.
FP12	Thanks to the Government's business-friendly policies, my company has increased on growth in sales revenue.
FP13	Thanks to the Government's business-friendly policies, my company has increased profitability.
FP14	Thanks to the Government's business-friendly policies, my company has increased the efficiency of using the resources.

To establish face validity, each item in the questionnaire was reviewed by subject matter experts to ensure it logically represented the intended construct and was relevant to the Malaysian electronics sector (see Table 6.10.5). Based on expert feedback, adjustments were made, including: (1) rewording or rephrasing items to improve respondent understanding, and (2) adapting content to better fit the Malaysian context. This review process helps ensure that each item appears suitable and relevant at face value. Further validation, such as factor analysis, may be conducted to provide additional statistical confirmation.

Table 6.10.5: Content and Face Validity

Expert ID	Designation	Experience	Affiliation	Expertise Area
A	Director	20+ years	Entrepreneur	Logistics and Supply Chain
B	Senior Lecturer	20+ years	Academician	Talent Development
C	Senior Manager	20+ years	Manufacturer	Technology Adoption
D	Project Manager	15+ years	ICT Consultant	Innovation and Technology adoption
E	Senior Lecturer	11+ years	Academician	Talent Development
F	Manager	20+ years	Academician	Adoption and performance

This operationalization structure ensures alignment with theoretical frameworks, notably the Resource-Based View (RBV), which underscores the importance of firm-specific resources and capabilities enhanced by government interventions. By systematically defining and measuring variables, this study provides a robust framework for analysing the impact of government support on firm performance in Malaysia's electronics industry.

6.11 Demographic Profile of the Respondents and Company

This section provides valuable insights into the characteristics of the companies and individuals who participated in the study, offering a basis for evaluating the relevance and applicability of the research findings. Understanding the demographic profile helps confirm the robustness of decisions and conclusions made, and allows readers to compare these findings with similar studies. As in Table 6.11.1 and Figure 6.11, this section outlines the demographic information of the respondents, focusing on the organizational backgrounds and respondent profiles, including company age, type, and sector, as well as individual attributes such as gender, age, race, marital status, educational level, and position within the company. This examination of the respondents' profiles enriches the context and relevance of the findings.

Table 6.11.1: Respondent's demography profile and company profile

No.	Demography	Description	Responses, N=71	Percentage
A.	Respondent Profile			
A1.	Gender	Male	67	94.37%
		Female	4	5.63%
A2.	Age	Less than 31 years	3	4.23%
		31-35 years	6	8.45%
		36-40 years	9	12.68%
		41-45 years	9	12.68%
		46-50 years	14	19.72%
		51-55 years	15	21.13%
		56-60 years	8	11.27%
		Above 60 years	7	9.86%
A3.	Race	Malay	16	22.54%
		Chinese	37	52.11%
		Indian	14	19.72%
		Others: Arab, Germans, American	4	5.63%
A4.	Marital Status	Married	60	84.51%
		Single	9	12.68%
		Divorced/Widow/Widower	2	2.82%
A5.	Education Level	Diploma	2	2.82%
		Bachelor	33	46.48%
		Master	21	29.58%
		PhD	15	21.13%
A6.	Position	Manager	55	77.46%
		Owner	5	7.04%
		Others	11	15.49%
B.	Company Profile			
B1.	Company Age	Above 10 years	61	85.92%
		Less than 5 years	6	8.45%
		5-10 years	4	5.63%
B2.	Company Type	Multinational Corporation (MNC)	43	60.56%
		Locally owned	25	35.21%
		Joint venture	3	4.23%
B3.	Sector	Services and Other Sectors	41	57.75%
		Manufacturing Sector	30	42.25%
B4.	Annual Sales Turnover			

B4a.	Manufacturing Sector	below RM300,000	2	2.82%
		between RM300,000 - RM15 million	1	1.41%
		between RM15 million - RM 50 million	4	5.63%
		above RM50 million	23	32.39%
B4b.	Services and Other Sectors	below RM300,000	2	2.82%
		between RM300,000 - RM3 million	8	11.27%
		between RM3 million - RM 20 million	15	21.13%
		above RM20 million	16	22.54%
B5.	Number of full-time employees			
B5a.	Manufacturing Sector	Less than 5	0	0.00%
		Between 5 and 75	2	2.82%
		Between 75 and 200	3	4.23%
		More than 200	25	35.21%
B5b.	Services and Other Sectors	Less than 5	1	1.41%
		Between 5 and 30	8	11.27%
		Between 30 and 75	8	11.27%
		More than 75	24	33.80%
B6.	Business Scale: Large/SME (SMECorp, n.d.)			
B6a.	Manufacturing Sector	Micro		
		Small	2	2.82%
		Medium	3	4.23%
		Large	25	35.21%
B6b.	Services and Other Sectors	Micro	1	1.41%
		Small	5	7.04%
		Medium	11	15.49%
		Large	24	33.80%

This demographic and company profile table provides a comprehensive breakdown of respondents (N=71) and their companies in terms of personal, organizational, and business attributes. Here's an interpretation of each section:

6.11.1 Respondent Profile

1. Gender: The majority of respondents are male, comprising 94.37% (67 individuals), with only 5.63% (4 individuals) being female, indicating a male-dominated sample.
2. Age: The age distribution is diverse:
    - The largest groups are aged 51-55 years (21.13%) and 46-50 years (19.72%).
    - Other notable groups include 36-40 years and 41-45 years, each representing 12.68%.

- Smaller age groups include less than 31 years (4.23%) and above 60 years (9.86%), suggesting a predominantly mid-to-late career respondent base.

3. Race: The majority are Chinese (52.11%), followed by Malay (22.54%) and Indian (19.72%), with a small percentage (5.63%) from other backgrounds (Arab, German, American).
4. Marital Status: A high proportion of respondents are married (84.51%), with smaller percentages being single (12.68%) and divorced or widowed (2.82%).
5. Education Level: Most respondents have higher education:
    - Bachelor's degrees are most common (46.48%), followed by Master's degrees (29.58%) and PhDs (21.13%).
    - Only a few respondents hold a Diploma (2.82%).
6. Position: The majority are in managerial roles (77.46%), with a few respondents identified as owners (7.04%) or other roles (15.49%).

6.11.2 Company Profile

1. Company Age: Most companies are well-established with above 10 years in operation (85.92%), while a small portion are younger, with less than 5 years (8.45%) or 5-10 years (5.63%).
2. Company Type:
    - A significant proportion are Multinational Corporations (MNCs) (60.56%), while 35.21% are locally owned, and 4.23% are joint ventures.
3. Sector:
    - Services and Other Sectors dominate (57.75%), while Manufacturing comprises 42.25%, showing a substantial presence in both sectors.
4. Annual Sales Turnover:
    - Manufacturing Sector: Most companies report annual sales turnover above RM50 million (32.39%), with smaller groups reporting sales between RM15 million - RM50 million (5.63%) and below RM300,000 (2.82%).
    - Services and Other Sectors: This sector has a varied distribution, with 22.54% reporting turnover above RM20 million, followed by 21.13% reporting between RM3 million - RM20 million, and smaller percentages with lower turnovers.
5. Number of Full-Time Employees:
    - Manufacturing Sector: Companies with more than 200 employees represent the largest group (35.21%), indicating larger firms, while smaller segments have 5-75 employees (2.82%) and 75-200 employees (4.23%).
    - Services and Other Sectors: Companies with more than 75 employees (33.80%) dominate, with smaller groups having 5-30 employees (11.27%) and 30-75 employees (11.27%).
6. Business Scale:
    - Manufacturing Sector: Most firms are classified as Large (35.21%), with smaller percentages identified as Small (2.82%) and Medium (4.23%).
    - Services and Other Sectors: Similarly, most are Large (33.80%), while Small and Medium businesses constitute 7.04% and 15.49%, respectively.

This data is summarised in Figure 6.11.1 reveals that respondents are mostly experienced, male managers in well-established firms, predominantly MNCs within the services sector. The companies are large in size, as reflected by high employee counts and annual turnover, indicating that these firms are prominent players in the Malaysian electronics industry. The

education level and managerial roles of respondents suggest a knowledgeable sample base, adding credibility to the findings related to government interventions and firm performance.

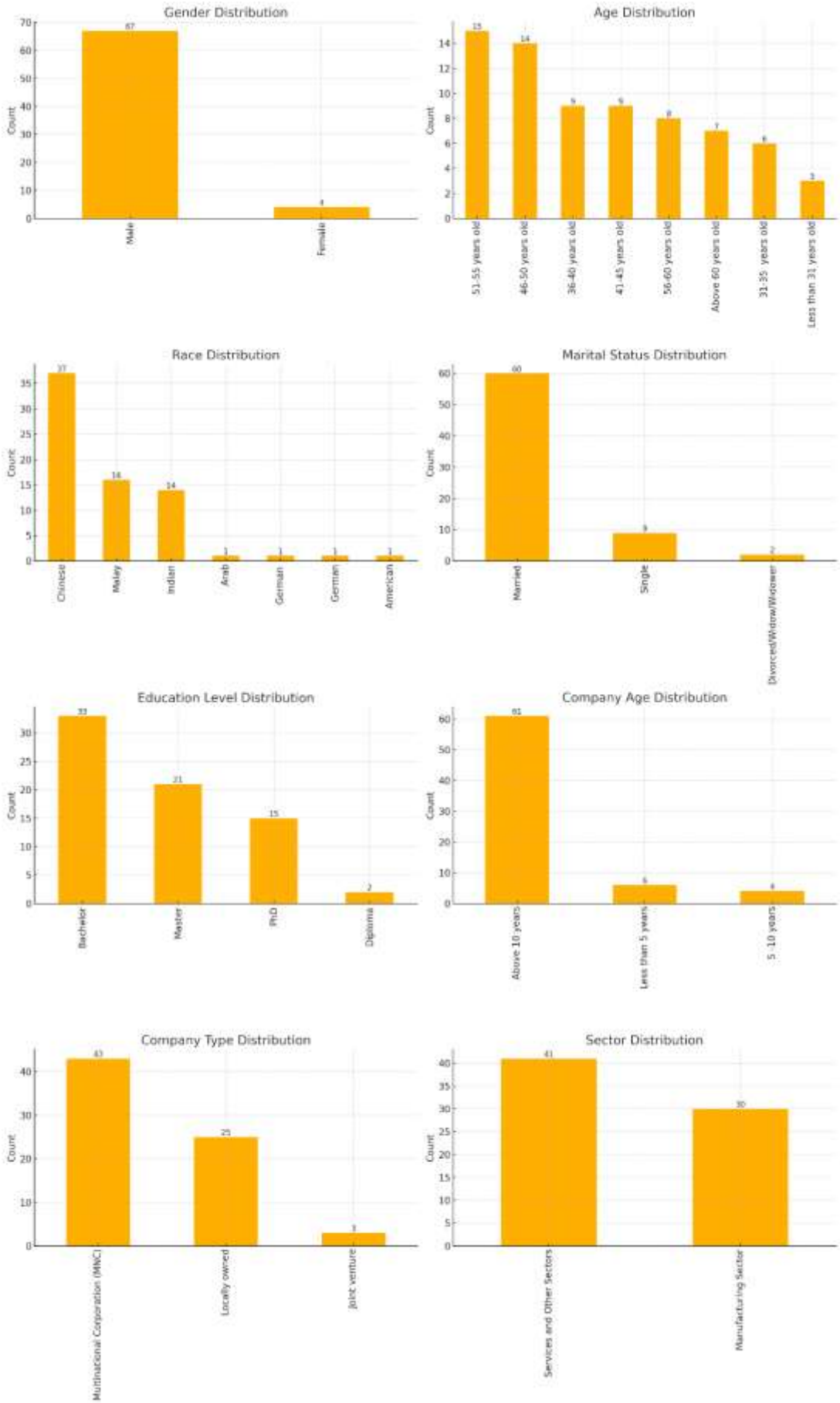


Figure 6.11.1 Graphical interpretation of the respondent and company profile.

6.12 Data analysis technique

After the data cleaning, the quantitative analysis process outlined is a structured approach to examine data for hypothesis testing and model evaluation. Figure 6.12.1 briefs explanation of each step and its objectives, along with accepted thresholds.

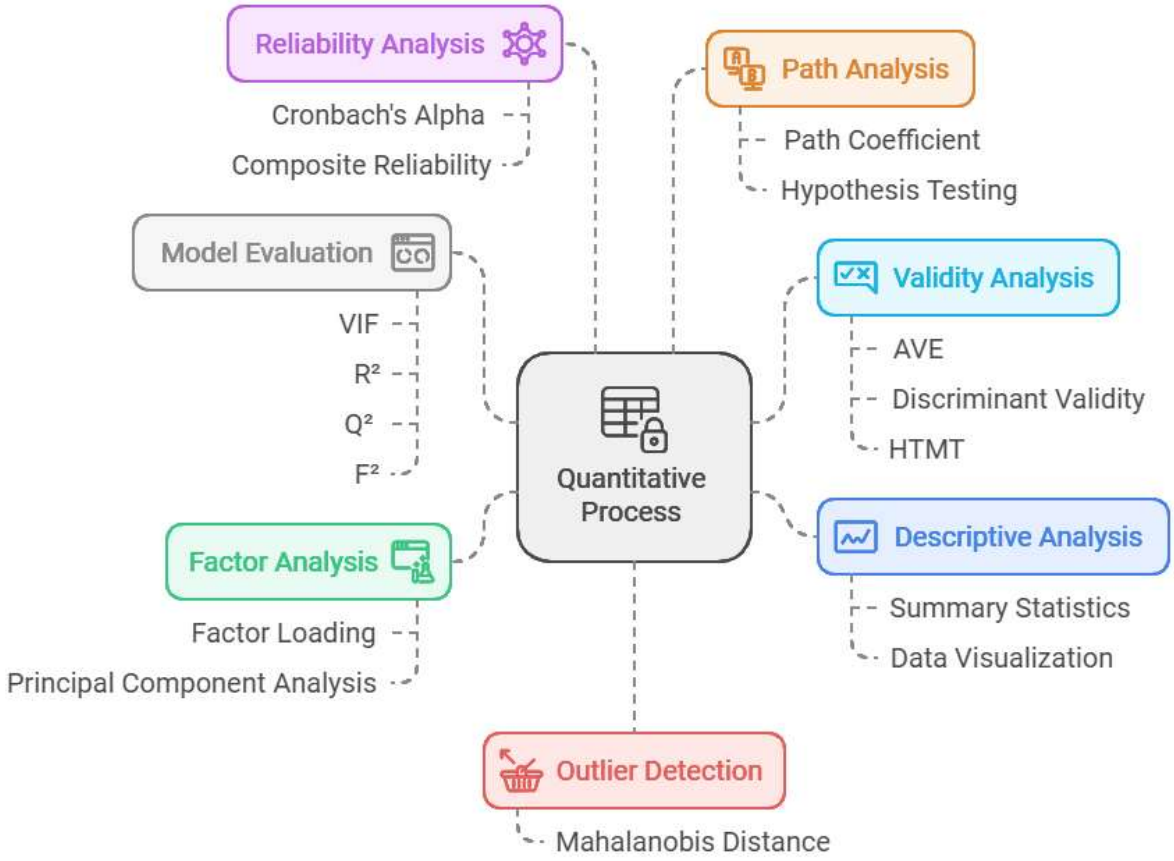


Figure 6.12.1: The statistic tool for the quantitative analysis

6.12.1 Outlier Detection (Mahalanobis Distance)

This tool identifies data points that are significantly different from others, which could bias results. Outliers are typically those with a Mahalanobis distance greater than a chi-square threshold ($p < 0.001$), based on degrees of freedom. Outliers were identified using Mahalanobis Distance, and RID 7, RID 13, and RID 24 were removed based on their extreme values, as shown in Figure 6.12.2.

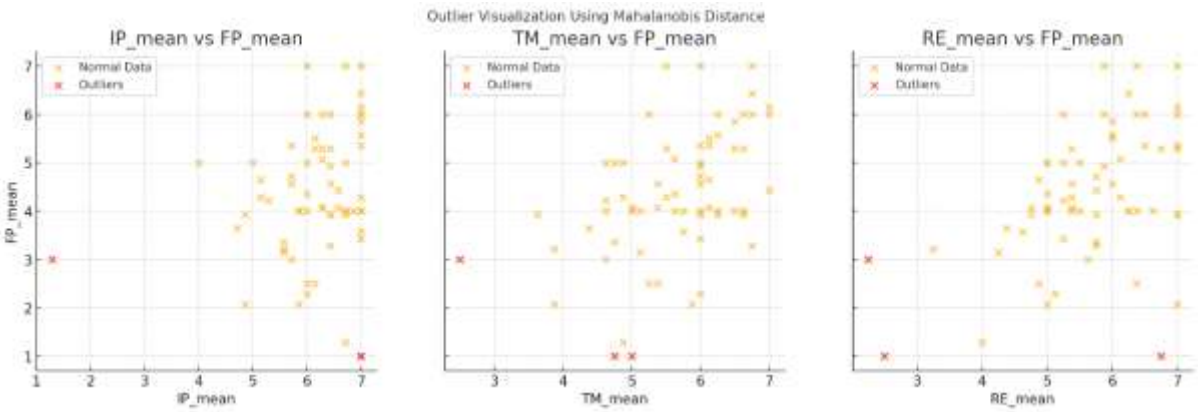


Figure 6.12.2: RID 7, RID 13 and RID 24 are outliers, with the graphical and Mahalanobis analysis

6.12.2 Descriptive Analysis

Provides a summary of data characteristics (e.g., mean, standard deviation) to give an overview of the dataset. This step does not have strict thresholds but rather provides insights into data distribution. For the respondents RID 10 (mean = 7), RID 23 (5), RID 27 (7), RID 30 (7) and RID 60 (6) who has the same answer across all the items might introduce noise into the data because such uniform responses are often indicative of:

a. **Low Engagement**: They might not have read each question and simply chose a midpoint or neutral response.
b. **Satisficing Behavior**: This occurs when respondents give "good enough" answers to complete the survey quickly, which can lead to inaccurate or non-discriminative data.
c. **Potential Misunderstanding**: They may have misinterpreted instructions and chosen a default score.

6.12.3 Factor Analysis (Factor Loading)

After the respondent removal, 63 respondents make up the usable data for further data analysis. Individual item's factor loading was used to verify the underlying structure of the data by examining correlations among variables. Loadings above 0.5 or 0.7 indicate strong relationships. However, the guidance on factor loadings of 0.30+ as potentially acceptable for new constructs is widely referenced in psychometrics, structural equation modelling (SEM) (Hair et al., 2011, Field, 2013, Tabachnick and Fidell, 2019, Costello and Osborne, 2005, Fabrigar et al., 1999).

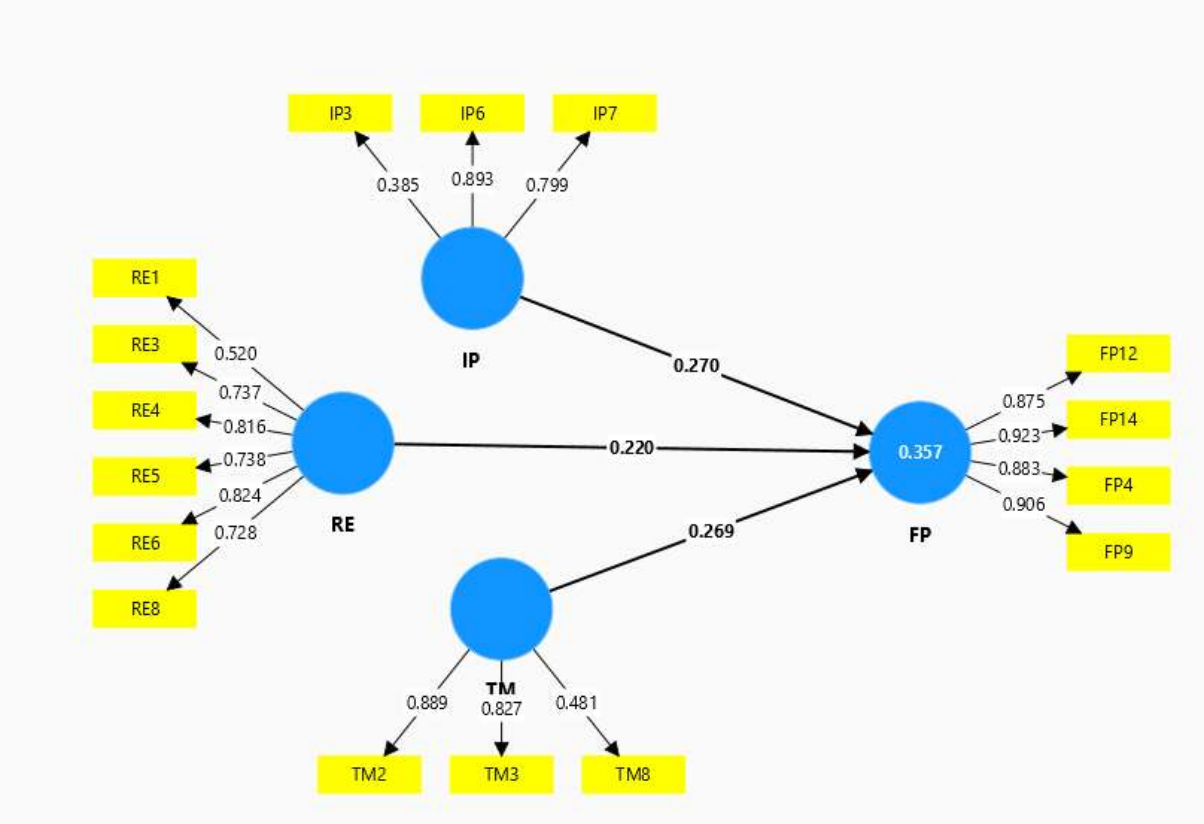


Figure 6.12.3: PLS Model using the SmartPLS

Table 6.12.1: Factor loading of the final SEM model

Item	FP Construct	IP Construct	RE Construct	TM Construct
FP12	0.875			
FP14	0.923			
FP4	0.883			
FP9	0.906			
IP3		0.385 (low)		
IP6		0.893		
IP7		0.799		
RE1			0.520 (moderate)	
RE3			0.737	
RE4			0.816	
RE5			0.738	
RE6			0.824	
RE8			0.728	
TM2				0.889
TM3				0.827
TM8				0.481 (low)

Note: FP items demonstrate high reliability consistent with a mature construct, IP, TM, and RE, as exploratory constructs, show varying levels of alignment.

In Figure 6.12.3 and Table 6.12.1, the final supported framework results **FP** is a mature construct, higher loadings are expected, and the results align with this expectation. All items within FP (FP12, FP14, FP4, and FP9) have strong loadings, ranging from 0.875 to 0.923, well above the commonly accepted threshold of 0.7. These high values suggest excellent internal consistency and confirm that the FP items reliably represent the construct.

In contrast, **IP**, **TM**, and **RE** are newly developed constructs, and the study is in an exploratory phase. Given this context, lower loadings can be more acceptable as the constructs are being refined. Within the IP construct, items IP6 (0.893) and IP7 (0.799) show acceptable loadings, indicating reasonable alignment with the construct. However, IP3 has a lower loading of 0.385, suggesting it may not strongly represent the IP construct. However, it could be considered for its holding theoretical significance.

For **RE**, most items have acceptable loadings: RE3 (0.737), RE4 (0.816), RE5 (0.738), RE6 (0.824), and RE8 (0.728) are all above the 0.7 threshold, supporting their inclusion in this exploratory phase. RE1, however, has a loading of 0.520, which, while lower, may still be acceptable as it is an exploratory context.

In the **TM** construct, TM2 (0.889) and TM3 (0.827) exhibit strong loadings, indicating they align well with the construct. TM8, on the other hand, has a lower loading of 0.481, suggesting weaker alignment. It might be reconsidered in future model refinements unless it holds theoretical importance.

In summary, while the FP items demonstrate high reliability consistent with a mature construct, IP, TM, and RE, as exploratory constructs, show varying levels of alignment. Factor loadings above 0.5 were considered acceptable for this study, while items with loadings below this threshold (e.g., IP3, TM8) were retained if they held theoretical significance. This criterion is in line with psychometric recommendations for exploratory research (Hair et al., 2011).

6.12.4 Reliability Analysis (Cronbach's Alpha, Composite Reliability)

Measures internal consistency of constructs. Cronbach's Alpha and Composite Reliability values above 0.7 are typically considered acceptable, indicating reliable scales. In exploratory research or initial studies with complex or new constructs, a CR threshold of 0.5 may be acceptable, as this level suggests moderate internal consistency, especially when higher reliability is difficult to achieve (Hair et al., 2011). Fornell & Larcker (1981) advocate for CR values over 0.6 as an acceptable level, especially if the Average Variance Extracted (AVE) is also adequate.

Table 6.12.2: Reliability and validity

	Cronbach's alpha	Composite reliability	Average variance extracted (AVE)
FP	0.919	0.942	0.804
IP	0.596	0.753	0.528
RE	0.823	0.873	0.539
TM	0.585	0.789	0.569

Table 6.12.2 provides reliability and validity statistics for four constructs: FP, IP, RE, and TM. The reliability analysis of the constructs revealed varying levels of internal consistency. For the Firm Performance (FP) construct, both Cronbach's Alpha (0.919) and Composite Reliability (0.942) scores were high, indicating excellent internal consistency and strong reliability. Regulatory Environment (RE) also demonstrated good internal consistency, with Cronbach's Alpha at 0.823 and Composite Reliability at 0.873, supporting its reliability. For Innovative Performance (IP), Cronbach's Alpha was low (0.596), signalling weaker internal consistency; however, the Composite Reliability of 0.753 suggests moderate reliability when accounting for factor loadings, which can be somewhat acceptable in exploratory studies. Talent Management (TM) showed low Cronbach's Alpha (0.585) but acceptable Composite Reliability (0.789), indicating that while item correlations within the construct might be weaker, the overall construct still demonstrates reasonable reliability in this exploratory context.

6.12.5 Validity Analysis (Average Variance Extracted [AVE], Discriminant Validity, HTMT)

For assessing the construct validity, an AVE above 0.5 indicates adequate convergent validity. Discriminant validity can be tested using the Fornell-Larcker criterion or HTMT (values below 0.85 or 0.90 for HTMT indicate acceptable discriminant validity).

In Table 6.12.2, the Average Variance Extracted (AVE) values indicate satisfactory convergent validity across the constructs. Firm Performance (FP) achieved a high AVE of 0.804, showing that it explains a significant proportion of variance in its indicators. The Innovation Performance (IP) construct, with an AVE of 0.528, suggests moderate convergent validity, meaning the items capture a meaningful level of variance despite lower Cronbach's alpha. Both Regulatory Environment (RE) and Talent Management (TM) have AVEs above the acceptable threshold of 0.5 (0.539 and 0.569, respectively), indicating that these constructs sufficiently explain variance in their items, supporting the reliability and validity of these constructs in the study.

Table 6.12.3: Discriminant validity Heterotrait-monotrait ratio (HTMT) Matrix

	FP	IP	RE	TM
FP				
IP	0.501			
RE	0.463	0.283		
TM	0.707	0.731	0.871	

The Heterotrait-Monotrait Ratio (HTMT) analysis presented here assesses the discriminant validity between the constructs Firm Performance (FP), Innovative Performance (IP), Regulatory Environment (RE), and Talent Management (TM). Discriminant validity ensures that each construct is distinct and measures a unique concept. Generally, HTMT values below 0.85 indicate good discriminant validity, though values up to 0.90 can be acceptable depending on study context.

In Table 6.12.3, most HTMT values fall well below 0.85, supporting the distinctiveness of the constructs. Specifically, the relationships between FP and IP (0.501), FP and RE (0.463), and FP and TM (0.707) confirm that FP is conceptually separate from IP, RE, and TM. Similarly, IP and RE (0.283) and IP and TM (0.731) are well below the threshold, affirming distinctiveness between these pairs. The relationship between RE and TM, at 0.871, approaches

the upper threshold, suggesting some overlap but still within an acceptable range for discriminant validity. Overall, these results indicate that the constructs in this study maintain sufficient discriminant validity, although the proximity of the RE and TM relationship to the threshold may warrant closer inspection in future analyses.

Validity measures, including AVE and HTMT, confirm that the constructs exhibit adequate convergent and discriminant validity, with most HTMT values below 0.85, indicating distinctiveness between constructs.

6.12.6 Path Analysis (Path Coefficient, Hypothesis Testing)

Evaluates the strength and direction of relationships between variables. Path coefficients typically require p-values < 0.05 to indicate statistically significant relationships.

Table 6.12.4: Path coefficients and its significant level

	Path coefficients	STDEV	T statistics	P values	Hypothesis
H1: IP -> FP	0.270	0.124	2.183	0.029*	Supported
H2: TM -> FP	0.269	0.139	1.936	0.053**	Partially Supported
H3: RE -> FP	0.220	0.124	1.772	0.077**	Partially Supported

*statistically significant supported; **marginally significant supported.

The Table 6.12.4 shows the path coefficients, standard deviations (STDEV), T-statistics, and P-values for the relationships between three independent variables: Innovative Performance (IP), Regulatory Environment (RE), and Talent Management (TM) and the dependent variable, Firm Performance (FP).

1. **IP -> FP**: The path coefficient for the relationship between Innovative Performance and Firm Performance is **0.270**, with a T-statistic of **2.183** and a P-value of **0.029**. Since the P-value is below the commonly accepted threshold of 0.05, this relationship is statistically significant. This indicates that Innovative Performance has a positive and significant effect on Firm Performance. Thus, hypothesis 1 statistically significant supported.
2. **RE -> FP**: The path coefficient for the Regulatory Environment's effect on Firm Performance is **0.220**. The T-statistic is **1.772**, with a P-value of **0.077**, which is above the 0.05 threshold but below 0.1. This suggests a marginal or borderline significance, meaning that Regulatory Environment may have a weak positive influence on Firm Performance but is not as statistically strong as the IP-FP relationship. Thus, hypothesis 2 marginally significant supported.
3. **TM -> FP**: Talent Management's effect on Firm Performance has a path coefficient of **0.269**, a T-statistic of **1.936**, and a P-value of **0.053**. This result is close to the 0.05 significance level, indicating that Talent Management has a positive effect on Firm Performance, but it is only marginally significant. Thus, hypothesis 3 marginally significant supported.

Innovative Performance (IP) has a statistically significant positive impact on Firm Performance (FP), while Talent Management (TM) shows a marginally significant positive effect on FP. The Regulatory Environment (RE) also positively impacts FP, though it is only borderline significant. These findings suggest that both IP and TM are important drivers of firm success,

with IP showing the strongest significant effect in this model. Thus, this supports the hypotheses that IP, TM, and RE positively influence FP, with IP showing the strongest effect.

6.12.7 PLS Model Fitting (SRMR, NFI, Chi-square, d_ULS, d_G)

Based on the model fit indices provided in Table 6.12.5, the model fit is marginally acceptable but not ideal. Here's a breakdown:

1. **SRMR (0.113)**: SRMR values below 0.08 are typically considered a good fit, while values below 0.10 are often acceptable in less strict contexts, especially for exploratory research. Since 0.113 is just slightly above this, the model might be considered somewhat acceptable, but it doesn't meet the usual cutoff for a strong fit.
2. **NFI (0.619)**: An NFI value above 0.90 is generally the benchmark for an acceptable fit, and values above 0.95 indicate a very good fit. The NFI of 0.619 is considerably below this threshold, suggesting that the model may need modifications to better align with the data.
3. **Chi-square (244.603)**: In SEM, a lower chi-square value relative to the degrees of freedom indicates a better fit. However, chi-square can be sensitive to sample size, which often makes it challenging to interpret on its own.
4. **d_ULS and d_G**: There are no strict cutoffs for these indices, but lower values generally indicate a better fit. The values here should be interpreted alongside the other fit measures.

In conclusion, The SRMR value of 0.113 indicates marginal model fit, suggesting that further refinement may be beneficial in future studies. Other indices, such as NFI (0.619), also reflect an exploratory rather than confirmatory fit.

Table 6.12.5: PLS Model Fitting (SRMR, NFI, Chi-square, d_ULS, d_G)

	Fitting Summary
SRMR	0.113
d_ULS	1.748
d_G	0.745
Chi-square	244.603
NFI	0.619

6.12.8 Model Evaluation (Variance Inflation Factor [VIF], R^2, Q^2, F^2)

Checks for multicollinearity and assesses the predictive power of the model. VIF values below 5 indicate acceptable multicollinearity, R^2 values closer to 1 represent high explanatory power, Q^2 values > 0 indicate predictive relevance, and F^2 values show effect size.

Table 6.12.6: Collinearity statistics (VIF) for individual item

Item	Variance Inflation Factor
FP12	2.839
FP14	3.917
FP4	2.798
FP9	3.193
IP3	1.273
IP6	1.317
IP7	1.623
RE1	1.259
RE3	2.262
RE4	2.982
RE5	2.131
RE6	3.144
RE8	1.748
TM2	1.777
TM3	1.749
TM8	1.033

The Variance Inflation Factor (VIF) values for this model provide insight into the multicollinearity among predictor variables. Generally, VIF values below 5 indicate that multicollinearity is not problematic, as each predictor contributes independently to the model without excessive overlap. In Table 6.12.6, the VIF values across the Firm Performance (FP), Innovation Performance (IP), Regulatory Environment (RE), and Talent Management (TM) constructs mostly range from 1.033 to 3.917, all within acceptable limits.

The FP items show VIF values between approximately 2.8 and 3.9, suggesting no significant multicollinearity concerns, although FP14 is slightly higher. IP items have lower VIF values (1.273 to 1.623), which confirms low multicollinearity within this construct. For RE items, the highest VIF observed is 3.144 (RE6), still well within acceptable range, indicating moderate but manageable multicollinearity. TM items have VIF values between 1.033 and 1.777, showing minimal multicollinearity concerns, particularly with TM8 displaying an ideal VIF.

In summary, the item's VIF values indicate that multicollinearity is within acceptable limits across all constructs, suggesting that each item contributes independently to the model. This ensures that the regression coefficients are stable and the model's results are unlikely to be biased by multicollinearity.

Table 6.12.7: Model Evaluation (VIF, R^2, Q^2, f^2)

	VIF	R^2	Q^2	f^2	Effect
IP -> FP*	1.340			0.085	Moderate
RE -> FP**	1.619	0.357	0.252	0.047	Small
TM -> FP**	2.044			0.055	Small

*statistically significant supported; **marginally significant supported.

For the overall model evaluation, the analysis of the **Variance Inflation Factor (VIF)** values shows that all predictors (IP, RE, and TM) have VIF scores below 3. Specifically, IP -> FP (1.340), RE -> FP (1.619), and TM -> FP (2.044) suggest there are no significant multicollinearity issues among these constructs. This indicates that IP, RE, and TM are distinct from each other in predicting FP, contributing independently to the model without excessive overlap, thus enhancing the reliability of these relationships.

The **R^2 value** for FP is 0.357, meaning that 35.7% of the variance in FP is explained by the predictors IP, RE, and TM. This R^2 value indicates a moderate level of explanatory power. While the predictors account for a meaningful portion of FP's variance, it also suggests that other factors not included in the model may influence FP. This model offers a reasonable foundation for explaining FP, though it could be expanded by considering additional relevant variables.

Regarding **predictive relevance (Q^2)**, the Q^2 value for FP is 0.252, indicating medium predictive relevance. Since Q^2 values above 0 imply predictive capability, this result suggests that the model can predict FP reasonably well. According to established benchmarks (0.02 = small, 0.15 = moderate, 0.35 = large) by Hair et al., (2017), a Q^2 of 0.252 supports the idea that IP, RE, and TM collectively make meaningful contributions to predicting FP.

Effect sizes (f^2) show small to moderate impacts for each predictor on FP. Specifically, IP -> FP (0.085) suggests a modest impact, RE -> FP (0.047) represents a small effect, and TM -> FP (0.055) also shows a minor contribution. According to Cohen (1988)'s benchmarks (0.02 = small, 0.15 = moderate, 0.35 = large), these values indicate that each construct plays a role in explaining FP, although none of them have a particularly strong individual influence.

In summary, IP, RE, and TM contribute meaningfully to predicting FP, with moderate explanatory and predictive power overall. The model benefits from distinct and reliable predictor relationships (as shown by VIF values), moderate explanatory power (R^2), and medium predictive relevance (Q^2). Each predictor's impact on FP is modest but meaningful, supporting the model's utility in exploring the drivers of FP.

6.13 Limitations

Sample and Response Limitations:
The survey includes 71 respondents from the IEM network, with a modest response rate that is expected typically for Malaysian executive surveys and the exact number of invitations sent by IEM was not transparent and disclosed to the researchers. This introduces two constraints: (i) potential IEM-affiliation bias (e.g., more engaged or resource-rich firms may be over-represented) and (ii) possible non-response bias. Accordingly, the results should be interpreted as directional evidence for IEM-affiliated E&E firms rather than as population estimates for all Malaysian electronics firms. Future work should broaden recruitment beyond professional-society networks and, where feasible, implement follow-up bias checks or weighting to assess representativeness.

Measurement validity and reliability Limitation:
The measurement model shows strong reliability for Firm Performance (FP), Cronbach's α = 0.919, Composite Reliability (CR) = 0.942, AVE = 0.804 and acceptable reliability. While for Regulatory Environment (RE), α = 0.823, CR = 0.873, AVE = 0.539. By contrast, Innovation Performance (IP) and Talent Management (TM) exhibit marginally low internal consistency (α = 0.596 and α = 0.585, respectively) even though their CRs are moderate (IP = 0.753; TM = 0.789) and their AVEs exceed the 0.50 convergent-validity threshold (IP = 0.528; TM = 0.569).

In practical terms, alpha reflects how tightly the items move together; values around 0.60 imply the items may not tap a single latent dimension consistently (here, depressed by low-loading items such as IP3 = 0.385 and TM8 = 0.481) despite some strong indicators (e.g., IP6 = 0.893, IP7 = 0.799; TM2 = 0.889, TM3 = 0.827). Composite reliability down-weights weak items, hence the higher CRs. Composite reliability (CR) is usually the better indicator for latent constructs, especially in CFA/PLS-SEM, because it uses the actual item loadings from the model and doesn't assume all items are equally good. Cronbach's α assumes tau-equivalence (all items have equal true-score loadings), so it often underestimates reliability when loadings differ. In this case of the disagreement CR $\geqslant$ 0.70 but α < 0.70, further research may consider to dropping weak items, and check AVE (aim $\geq$ 0.50).

AVE > 0.50 indicates each construct still captures sufficient variance on average. Discriminant validity is acceptable (HTMT $\leqslant$ 0.871 and below the common 0.85 – 0.90 guideline). At the model level, global fit suggests room to improve (SRMR = 0.113; NFI $\approx$ 0.619), reinforcing the need to tighten both measurement and theory in future iterations. Taken together, these results support exploratory use of IP and TM but warrant refinement (e.g., revise or drop weak items like IP3/TM8, expand item pools, run cognitive pretests, and re-validate via CFA/PLS on a new sample).

Hypothesis Evaluation Limitations (Interpreting marginal significance):
In Section 6.12.6, we report one clearly significant path and two marginal ones. Specifically, IP ➞ FP is positive and statistically significant (β = 0.27, p = 0.029), whereas TM ➞ FP (β = 0.27, p = 0.053) and RE ➞ FP (β = 0.22, p = 0.077) are positive but only marginally significant supported at conventional thresholds. A p-value is the probability of observing an effect at least this large if the true effect were zero; values < 0.05 are typically termed "significant," while ~0.05–0.08 indicate limited evidence and should be treated cautiously. The standardized coefficient β expresses effect size: for example, β = 0.27 means a one–standard deviation increase in the predictor is associated with a 0.27 SD increase in firm performance, holding other predictors constant. Given these results, we avoid labeling H2 (TM➞FP) and H3

(RE→FP) as "supported." Instead, we describe them as positive, marginally significant supported, modest associations that warrant replication with larger samples, additional controls, and tests of mediation/moderation.

Model fit and Omitted Variables:
For transparency, we also note the model explains a moderate share of variance (R^2 (FP) ≈ 0.36), underscoring that other, unmeasured factors likely contribute to firm performance. In others word, indicating that the three predictors (IP, TM, RE) account for about a third of the observed differences. Global fit indices are suboptimal for a well-fitting model (SRMR = 0.113; NFI ≈ 0.619). In practice, R^2 reflects explanatory power (higher is better), SRMR is the average discrepancy between observed and model-implied correlations (values < 0.08 are typically considered good), and NFI gauges relative fit on a 0–1 scale (values closer to 1.0 indicate better fit). However, for the exploratory research is still acceptable.

Together, these figures suggest that additional determinants of performance are not yet captured. Future studies should extend the model to include factors such as capital intensity, export exposure, supply-chain position, digital/Industry 4.0 maturity, infrastructure/logistics quality, and customer concentration; test interactions (e.g., TM×IP, RE×IP) and mediators (absorptive capacity); and consider longitudinal designs with objective metrics. Methodologically, we also recommend refining indicators, re-estimating with larger samples, and benchmarking fit with CB-SEM or PLS-Predict/K-fold procedures to reassess predictive performance.

6.14 Chapter Conclusion

This chapter has provided a comprehensive analysis of the quantitative findings from the study, examining the impact of government interventions on firm performance within Malaysia's electronics industry. Drawing from the soft theory of Resource-Based View (RBV), this study conceptualized three new primary constructs: Innovative Performance (IP), Talent Management (TM), and Regulatory Environment (RE) whereas firm-specific resources that government policies and initiative can enhance to drive competitive advantage and performance outcomes.

The data analysis revealed insights into the relationships between these novel constructs and the matured Firm Performance (FP). IP demonstrated a statistically significant positive effect on FP, underscoring the crucial role of government-supported innovation initiatives, such as R&D funding and technology adoption incentives, in enhancing the competitiveness of firms. This finding aligns with the RBV perspective, where the ability to innovate is a valuable, rare, and inimitable resource that can lead to sustained competitive advantage.

TM and RE also showed positive effects on FP, although with marginal significance. These results indicate that while TM and RE contribute to FP, their impact may be more variable across firms and depend on how well specific government interventions align with firms' strategic goals. The moderate influence of TM highlights the importance of government efforts in talent development, such as educational programs and skill-building initiatives, which help firms build a capable workforce and improve overall productivity. Meanwhile, the RE construct underscores the necessity of a stable and supportive regulatory framework that minimizes operational barriers and ensures fair business practices.

The analysis also highlighted the importance of reliability and validity in measuring these constructs, especially considering that IP, TM, and RE were newly developed for this study. While FP, as a mature construct, exhibited high internal consistency while the exploratory

constructs had moderate reliability, which is acceptable given their developmental nature. This reinforces the need for continued refinement of these measures to ensure their robustness and applicability in similar research contexts.

Overall, the findings validate the hypotheses that government interventions in IP, TM, and RE positively influence FP, with the strongest effect observed in IP. The mixed-method approach of combining qualitative and quantitative insights has allowed for a holistic examination of the topic, bridging theoretical frameworks with empirical evidence. By aligning with RBV principles, this chapter demonstrates that government-supported resources within firms are integral to achieving higher performance, especially in a highly competitive and technology-driven industry like electronics.

In conclusion, the quantitative findings of this chapter reinforce the strategic importance of government interventions in enhancing key resources that drive firm performance. The study suggests that Malaysia's government could optimize its policies by focusing on targeted support for innovation, talent development, and regulatory improvements to further strengthen the competitiveness of the electronics sector. These insights not only contribute to academic understanding but also provide valuable recommendations for policymakers and industry leaders in crafting strategies that bolster firm success in an evolving market landscape.

7 Conclusion and Strategic Roadmap

7.1 Summary of key points

This study set out to examine how government interventions could enhance the performance of Malaysia's electronics industry, focusing on innovation (IP), talent (TM), and the regulatory environment (RE). The **key findings** can be summarized as follows:

- **The electronics industry is pivotal** to Malaysia's economy but faces critical challenges: limited R&D and innovation, talent shortages and brain drain, and regulatory inefficiencies. These challenges constrain firms' competitiveness and growth potential.
- **Government action is essential** in addressing these challenges, as evidenced by both qualitative case studies and quantitative analysis. Our RBV-informed empirical model showed that IP, TM, and RE together explain a substantial portion of firm performance variation, confirming that improvements in these areas (many of which require policy support) can yield significant gains.
- **Policy recommendations** were developed in seven core areas: boosting R&D and innovation (via funding, partnerships, culture), strengthening talent pipelines (education reform, skills training, stemming brain drain), refining the regulatory framework (streamlining processes, increasing transparency, aligning with global standards), and learning from Asian best practices to ensure strategies are effective and sustainable. The recommendations are interlinked and mutually reinforcing – for instance, better talent enhances innovation, and a better regulatory environment amplifies the benefits of both.

Original contributions of this study include an integrated policy framework specifically tailored for Malaysia's electronics ecosystem, the novel combination of qualitative and quantitative evidence to support policy proposals, and up-to-date insights reflecting post-2020 realities (like the need for digital skills and supply chain resilience in a pandemic/post-pandemic context). We also emphasize regional and global context, ensuring the study speaks to international readers by situating Malaysia's experience within broader technological and policy trends.

7.2 Final thoughts on the importance of strategic government interventions

The evidence and analysis presented make a compelling case that strategic government interventions in innovation, talent, and regulatory policy are not just beneficial but **crucial** for the future of Malaysia's electronics industry. Market forces alone are insufficient to overcome the structural issues identified – without deliberate policy measures, Malaysia risks its electronics sector plateauing or losing ground to more proactive economies.

Government interventions act as a catalyst: they can significantly reduce the risk and cost for firms to innovate (through grants, tax incentives), dramatically expand the quality and quantity of talent (through education and training reforms), and remove friction from the business environment (through smart regulation). These improvements enable firms to focus on value-adding activities – designing new products, scaling production, moving up the value chain – rather than being mired in constraints. In essence, the government's role is to **create an ecosystem** in which companies can thrive and compete globally. This aligns with the experiences of other successful countries, where public policy played a pivotal part in fostering innovation ecosystems (South Korea, Taiwan, Singapore, etc., all had heavy initial government involvement in their tech sectors).

It is also important to note that such interventions must be executed with **good governance** and adaptability. Policies should be evidence-based (as we have attempted here), inclusive of

stakeholder input (to ensure buy-in and practicality), and flexible to adjust to feedback and changing conditions. The goal is not a heavy-handed government direction of the industry, but rather a facilitative role – **steering rather than rowing**, to borrow an analogy. The private sector remains the driver of day-to-day innovation and efficiency; government provides the compass, the wind in the sails, and occasionally, course correction if needed.

The stakes are high. The electronics industry is not only a significant contributor to GDP and exports, but also a linchpin for Malaysia's aspirations to be a high-tech, high-income nation. Success in this industry could spur positive spillovers – developing local supply chains, inspiring STEM education, attracting foreign investment in advanced sectors – thereby accelerating economic transformation. Conversely, failure to act decisively could see Malaysia fall into the middle-income trap, with its electronics sector stuck in low-value activities while competitors move ahead in design, R&D, and next-gen manufacturing.

7.3 Vision for the future of Malaysia's electronics sector

Looking ahead, we can envisage a future where Malaysia's electronics sector is characterized by:

- **Continuous Innovation:** Firms innovate regularly, some producing home-grown world-class technologies. Malaysia is not just assembling others' innovations but creating and patenting its own, especially in niche domains (e.g., power electronics, embedded systems for Islamic fintech, IoT solutions for palm oil industry automation – combining domain strengths with electronics). Government R&D centers and universities act as ongoing fountains of new ideas and talent, closely tied to industry needs.
- **World-Class Talent Base:** The sector is supported by a robust pipeline of talent – bright engineers, skilled technicians, astute tech managers – drawn from Malaysian universities and attracted from abroad. Brain drain has been reversed; many Malaysian experts overseas have returned, bringing global experience. Young Malaysians see electronics and engineering as exciting, prosperous career paths, fueling the next generation of innovators. Women are also much more represented in the engineering workforce than before, doubling the talent pool (our policies were gender-neutral and inclusive, encouraging diversity in STEM).
- **Efficient and Ethical Business Environment:** Malaysia is known for its pro-business yet socially responsible environment. Investors laud the ease of setting up operations, the quick turnaround on permits, and the clarity of regulations. At the same time, Malaysian factories adhere to top-notch labour and environmental standards (no more shocking labour allegations in the news). This reputation gives Malaysian companies a competitive edge in global supply chains that increasingly value ESG compliance. The regulatory framework is agile – for example, Malaysia might be one of the first to have guidelines for AI in manufacturing or recycling of electronic waste, staying ahead of the curve.
- **Upgraded Industry Structure:** The industry value chain has deepened. There are more local SMEs providing specialized equipment, software, or components to big manufacturers – and some have grown into regional champions themselves. We have at least a few Malaysian brands or tech products recognized globally (maybe in B2B space like test instruments, or niche consumer devices). The reliance on foreign MNCs is now a balanced partnership – Malaysia still hosts many global companies (as a preferred destination for their high-tech production and R&D), but local firms have also spread their wings regionally and internationally.

- **Resilience and Foresight:** The sector is resilient to shocks – be it pandemics, supply chain disruptions or technological shifts. This is achieved through the agility of firms (thanks to highly skilled talent and innovation capability) and through supportive policy (like scenario planning and strategic initiatives by government – for example, already exploring opportunities in semiconductor 4.0, quantum tech, or whatever next frontier, keeping Malaysia ready for transitions). Essentially, the sector and policy apparatus embody the ethos of *technological forecasting and social change* – always scanning the horizon, investing in future competencies, and ensuring social benefits (good jobs, balanced development) flow from technological growth.

To realize this vision, the **strategic roadmap** emerging from this study can be summarized in a phased approach:
Short-Term (1-2 years): Implement quick wins – increase R&D grants and tax breaks (stimulate innovation immediately), launch the critical talent programs (scholarships, apprenticeships, etc.), establish the one-stop regulatory portal and cut red tape by 30% in key areas (e.g., reduce average permit approval times by 30%). Form the public-private task forces to drive these changes and monitor progress.

Medium-Term (3-5 years): See the fruition of early measures – a measurable rise in R&D expenditure-to-GDP, STEM enrollment, and ease-of-doing-business ranking. By year 5, aim for example to have R&D/GDP at 1.5%, STEM university intake up by 25%, and Malaysia back in the top 10 of World Bank's Ease of Doing Business (if that index were active). Evaluate and refine programs – e.g., adjust training curricula based on feedback, scale up what works (maybe PSDC-like centers in 3 more states if the initial ones show success). Also, medium-term, institutionalize some of these efforts so they survive political cycles (e.g., secure multi-year funding commitments for innovation and talent programs, embed some reforms into law where appropriate).

Long-Term (6-10 years): Harvest the outcomes – higher value addition in exports, a couple of Malaysian firms in the global supply chain spotlight, increased per capita income for the workforce due to higher skilled jobs. Continuously upgrade strategies: perhaps shift focus to emerging sub-sectors (like biomedical electronics or space technology) as the industry matures. By year 10, the aim could be that Malaysia's electronics sector is not just larger, but qualitatively transformed – known for innovation, top talent, and good governance.

This roadmap requires concerted effort from all stakeholders: **Government** must coordinate and stay committed to the course (providing consistent policy support and funds), **Industry** must actively participate (invest in innovation, work with educators, uphold standards), and **Educational Institutions** must align with this national agenda (producing talent and research that industry needs). Encouragingly, the alignment of interests is clear – everyone stands to gain from a more innovative, skilled, efficient industry.

Finally, **ethical integrity** and inclusivity should underpin these efforts. Growth should not come at the cost of worker welfare or environmental degradation – rather, Malaysia can differentiate itself by growing responsibly. All data use and analysis in this study adhered to ethical guidelines, and similarly, implementation of its recommendations should ensure fairness (e.g., support SMEs, not just large firms; opportunities for all demographics to join the tech workforce).

This study has limitations – it focused on three areas and did not deeply examine others like financing or specific sub-sector dynamics; it used cross-sectional data which cannot prove causality definitively. Future research could expand on these areas, perhaps examining the impact of digital financing on tech SME growth, or doing longitudinal studies to see how improvement in innovation/talent metrics over time correlates with performance changes (something our framework strongly suggests). There is also room to delve into firm-level case studies of companies that successfully transitioned to higher value activities – to extract micro-level insights complementary to our macro-level analysis.

In conclusion, Malaysia's electronics industry stands at a crossroads much like it did decades ago when it first opened to global investors. Then, the challenge was to establish Malaysia as a manufacturing base. Now, the challenge is to evolve Malaysia into an **innovation base**. With insightful policy intervention, unwavering focus on human capital, and adaptive governance, Malaysia can meet this challenge. The result will be a vibrant electronics ecosystem that not only contributes to economic prosperity but also positions Malaysia as a notable player in the global technology arena – ultimately realizing the nation's vision of a high-tech, inclusive, and sustainable economy.

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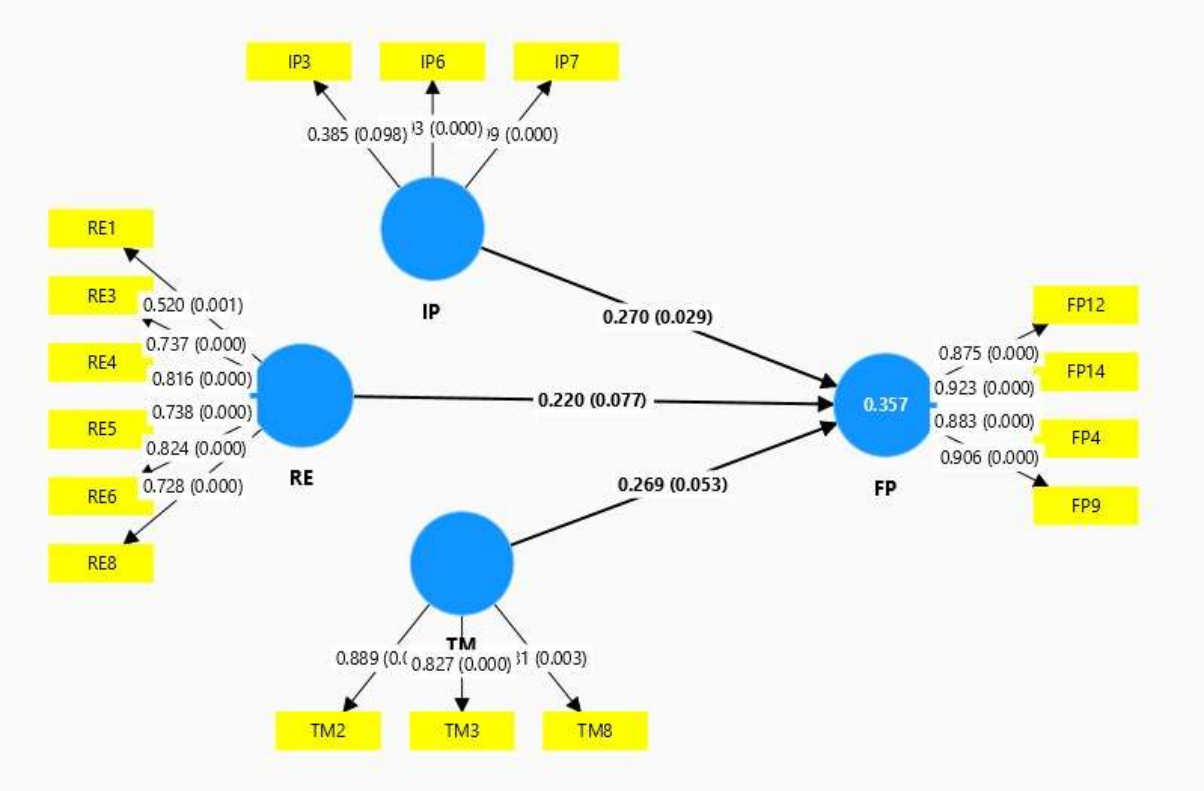
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IP3
IP6
IP7
0.385 (0.098)
(0.000)
(0.000)
IP
RE1
RE3
RE4
RE5
RE6
RE8
0.520 (0.001)
0.737 (0.000)
0.816 (0.000)
0.738 (0.000)
0.824 (0.000)
0.728 (0.000)
RE
0.270 (0.029)
0.220 (0.077)
0.269 (0.053)
0.357
FP
FP12
FP14
FP4
FP9
0.875 (0.000)
0.923 (0.000)
0.883 (0.000)
0.906 (0.000)
TM
0.889 (0.0
0.827 (0.000)
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TM2
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