MINISTRY OF HUMAN RESOURCES

TalentCorp
GROUP OF COMPANIES

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

Sector:
Medical Devices

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Preface by the Group Chief Executive Officer of TalentCorp

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

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

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

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

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

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

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

Thomas Mathew
Group Chief Executive Officer
Talent Corporation Malaysia Berhad

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

Thomas Mathew
Group Chief Executive Officer
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Executive Summary

The global Medical Devices sector is evolving rapidly, driven by the rapid advancement of AI, Digital, and Green Economy practices. AI is improving diagnostics and manufacturing, digital tools are enhancing efficiency and data management, while sustainable practices focus on eco-friendly materials and energy efficiency. As the development of these trends converges, they are creating a skills gap, as new expertise in AI and digital tools is needed, and this may lead to job displacement due to automation. Despite concerns, these trends present new and improved opportunities for those who adapt and embrace change through upskilling and relevant training.

In 2023, the global medical devices market size was valued at USD518.46 billion (RM2.38 trillion). This value is projected to grow from USD542.21 billion (RM2.49 trillion) in 2024 to USD886.80 billion (RM4.08 trillion) by 2032, exhibiting a compound annual growth rate (CAGR) of 6.3% during the forecast period. [1]

This growth is mainly driven by factors such as an ageing population, increasing prevalence of chronic diseases, advancements in technology, and an expanding healthcare access in developing regions. Therefore, understanding the shifts in these segments and the evolving trends in AI, Digital, and Green Economy practices is essential for navigating the medical device market, whether in manufacturing, investment, or healthcare delivery.

In Malaysia, the projected revenue in the medical devices market is expected to reach USD3.31 billion (RM15.2 billion) in 2024. Out of this, cardiology-based medical devices are anticipated to be the largest contributing factor, with a projected market volume of USD525.5 million (RM2.42 billion) in the same year. Additionally, the market is also expected to witness a steady CAGR between 2024 and 2029 of 7.51%, which exceeds the global growth, resulting in a market volume of USD4.75 billion (RM21.87 billion) by 2029.[2] This positive growth aligns with Malaysia's rank as the world's top offshore manufacturing hub for medical devices. Malaysia has solidified its position with nearly 300 medical devices produced primarily in Penang. Notable manufacturers, including B. Braun, Smith & Nephew, and Boston Scientific. are engaged in a variety of activities, from serving as regional headquarters and manufacturing to conducting research and development (R&D).

Malaysia's Medical Devices sector is poised for a transformative shift over the next three (3) to five (5) years, propelled by advancements in AI, Digital, and Green Economy trends within the country's Medical Devices sector and shaped by the evolving global landscape. This shift is set to bring significant changes in the Medical Devices sector, impacting the Malaysian workforce and necessitating a shift in skills and competencies to meet the much-needed evolving demands. Contributing RM2 billion to the nation's gross domestic product (GDP) and with RM8.2 billion in imports and RM31.1 billion in exports, the Medical Devices sector, which employs over 70,000 people, must evolve to broaden its product range into higher-end categories.[3] This evolution will certainly support its human resource development, R&D, and regulatory compliance in the long run. This evolution will also further strengthen Malaysia's standing among regional and global peers, ensuring that the domestic workforce remains robust and capable of meeting the shifting needs of the sector.

Artificial Intelligence (AI) technologies are set to revolutionise the medical devices manufacturing process by enhancing efficiency, accuracy, and innovation. From R&D to production and quality control, AI will streamline operations, reduce errors, and accelerate time-to-market for new therapies. This shift will drive increased demand for professionals skilled in AI and data analytics, who are capable of developing and managing AI-driven systems. In response, the Malaysian government has placed a strategic emphasis on AI development, recognising its potential to transform industries and boost national and labour market competitiveness. By launching the National AI Framework in 2019, Malaysia has outlined its roadmap for comprehensive AI adoption across sectors such as healthcare, agriculture, finance, and transportation.

Digital encompasses the integration of digital technologies into all areas of medical device manufacturing. This includes the use of the Internet of Things (IoT) for real-time monitoring, blockchain for secure data management, and advanced software for predictive maintenance and process optimisation. Consequently, there will be a growing demand for a workforce skilled in digital tools and platforms, with strong capabilities in cybersecurity, digital literacy, and systems integration. Recently, the Malaysian government has introduced the Digital Health Blueprint to accelerate the adoption of digital technologies in healthcare, including the Medical Devices sector. The blueprint outlines strategies to enhance digital infrastructure, data interoperability, and cybersecurity to support digital healthcare services. On top of that, the Malaysian government has introduced and launched the Malaysia Digital Economy Blueprint (MDEB) which outlines Malaysia's national digital transformation initiatives. The blueprint also includes provisions for enhancing digital infrastructure and capabilities across sectors, including healthcare and pharmaceuticals. It aims to create a conducive environment for digital innovation and economic growth.

Green Economy initiatives have seen Malaysia commit to various environmental sustainability goals, including reducing carbon emissions and increasing the use of renewable energy. To support this transition, employees will need training in sustainable practices and environmental regulations. To further accelerate Malaysia's Green Economy efforts, the government has launched key policies and initiatives such as the National Green Technology Policy (NGTP) and the Malaysia Renewable Energy Policy. The NGTP promotes the adoption of green technologies and practices across various sectors, including Medical Devices and Healthcare, encouraging companies to implement energy-efficient technologies, reduce carbon footprints, and adopt sustainable manufacturing practices. Additionally, the Malaysian Investment Development Authority (MIDA) provides incentives and grants to encourage investments in green technologies and sustainable practices within the Medical Devices sector, supporting companies in adopting environmentally friendly processes and technologies.

1. Fortune Business Insight, Medical Devices Market to Surge at 6.3% CAGR over 2024 to 2032; Growing Incidence of Chronic Conditions to Boost Market Growth, 29 April 2024, <https://www.fortunebusinessinsights.com/press-release/medical-devices-market-9074>; Malaysian Investment Development Authority, Malaysia poised to capture medical device manufacturing market, 26 July 2024, <https://www.mida.gov.my/mida-news/malaysia-poised-to-capture-medical-device-manufacturing-market/>
2. Statista, Medical Devices - Malaysia, <https://www.statista.com/outlook/hmo/medical-technology/medical-devices/malaysia#analyst-opinion>
3. Ministry of Investment, Trade, and Industry, New Industrial Master Plan 2030: Medical Devices Industry (NIMP 2030), 2023

The impact study for the Medical Devices sector has assessed a total of 57 roles across nine (9) job clusters. The nine (9) job clusters are:

1. Research and Development
2. Engineering and Maintenance
3. Process Development/Manufacturing Science and Technology (MS&T)
4. Production
5. Quality Assurance and Quality Control (QA & QC)
6. Regulatory, Compliance and Security
7. Site Management
8. Sustainability
9. Distribution, Marketing and Business Development

The study also identified four (4) emerging roles. These roles are tailored to future technological advancements, industry trends, and societal changes. By focusing on these emerging roles, organisations can drive innovation, adopt sustainable practices, and remain competitive and compliant with evolving regulations and market demands. Additionally, the study identified six (6) highly impacted roles, 39 medium impacted roles, and eight (8) low impacted roles.

The focal point of the impact study centres on roles significantly affected by the growth trends of AI, Digital, and Green Economy. Due to these trends, highly impacted roles are significantly impacted by

advanced data analysis tools, automation, and digital technologies that enhance testing, predictive maintenance, and manufacturing processes. Thus, it is concerning that within the next three (3) to five (5) years, approximately 21% of the workforce, or around 13,000 employees, could face job risks, according to projections from the TalentCorp Demand Model Projection. Hence, the workforce must be adept at leveraging AI tools to analyse large datasets, predict outcomes, and optimise processes effectively.

Meanwhile, the medium and low impacted roles are experiencing slower adoption of new technologies due to over-reliance on human-centric skills. Based on assessments and industrial feedback, 79% or 49,000 of medium and low impacted roles require upskilling related to AI, Digital, and Green Economy. Specifically, out of the 79% mentioned, 44% of medium impacted roles need to upskill to progress and perform beyond current conservation job expectations. Meanwhile, 35% of the low impacted roles do not require mandatory upskilling but are advised to perform continuous self-improvement to maintain relevance and make informed decisions that relate to their daily role tasks.

The impact study assessment identifies eight (8) initiatives across the talent ecosystem to adapt to AI, Digital, and Green Economy trends within the Medical Devices sector. These initiatives have been grouped into four (4) categories based on the leading and enabling entities: **Government, Industry Players, Academia,** and **Training Providers**:

GOVERNMENT	**IN1** Provide Funding and Incentives **IN2** Implement Regulatory and Policy
INDUSTRY PLAYERS	**IN3** Implement Talent Development Programme **IN4** Initiate and Drive Research and Innovation
ACADEMIA	**IN5** Design and Update Curriculum Development Plan **IN6** Establish and Enhance Internship and Work Readiness Programmes
TRAINING PROVIDERS	**IN7** Create and Deliver Content Development Strategies and Programmes **IN8** Develop and Manage Certification and Credentialing Programmes

Chapter 1:

Introduction of the Study

Introduction of the Study

Purpose of the Study

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

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

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

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

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

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

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

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

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

Malaysia is also making significant strides in Green Economy

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

This is in line with the 12th Malaysia Plan (2021–2025) that outlines the nation's aspiration to achieve net-zero greenhouse gas (GHG) emissions as early as 2050. Complementing this, the National Energy Policy (2022–2040) sets the foundation for transforming the energy landscape towards sustainability. In line with these objectives, the Malaysian Government has also developed the National Energy Transition Roadmap (NETR) to accelerate the shift from a traditional fossil fuel-based economy to a high-value Green Economy. Malaysia's efforts are reflected in its leading position in the World Economic Forum Energy Transition Index, ranking 1st in ASEAN and 35th globally.[5]

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

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

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

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

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

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

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

Chapter 2:
Approach and Methodology

Approach

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

Research Techniques

The qualitative and quantitative research techniques were as follows:

Research Methodology

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

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

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

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

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

AI & Digital

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

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

Green Economy

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

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

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

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

HIGH

Roles at risk of convergence or displacement

Need to pivot to adjacent role and reskill

MEDIUM

Roles still relevant

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

LOW

Roles not severely impacted

Require ongoing self-improvement to stay relevant

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

Key Stakeholders Engaged in the Study

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

Stakeholders and their Contributions to the Study

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

Stakeholders' Selection Criteria

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

01

HOLISTIC SECTOR COVERAGE

Comprehensive coverage of industry players across all sub-sectors and the entire value chain

02

STRONG BRAND PRESENCE

Widespread visibility and influence within the sector

03

SIZEABLE EMPLOYMENT COVERAGE

Comprehensive coverage and employee counts across all roles included in the assessment

04

SIGNIFICANT TURNOVER

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

During the study conducted from April to September 2024, we consulted 23 experts from **14** organisations during workshop, along with **two (2)** separate engagements with industry stakeholders

Key Facts and Figures of Impact Study Stakeholder Engagements

In-Depth Interviews	Validation Workshops
Industry Players : 14	Association : 1

Chapter 3:
Sector Overview

The Medical Devices sector, both globally and in Malaysia, is on the cutting edge of innovation, driven by AI, Digital, and Green Economy practices. AI acts as the catalyst, enhancing the sector through advanced diagnostics, manufacturing, and digital tools that streamline efficiency and data management. Meanwhile, sustainable practices are taking root, focusing on eco-friendly materials and energy efficiency. These advancements are widening the skills gap, as expertise in AI and digital tools becomes the new gold standard, potentially leading to job displacement due to automation. However, they also unlock new opportunities for those who adapt through upskilling and training.

Overview of the Global Trends in the Medical Devices Sector

The global medical devices market size was valued at USD518.46 billion (RM2.38 trillion) in 2023. Positively, it is projected to grow from USD542.21 billion (RM2.49 trillion) in 2024 to USD886.8 billion (RM4.08 trillion) by 2032, exhibiting a CAGR of 6.3% during the forecast period.[6]

The global medical devices market is on a trajectory of steady, robust growth, propelled by a combination of factors. These include an ageing population, a rising incidence of chronic diseases, continuous advancements in medical technology, and the increasing availability of healthcare in developing countries and regions.

Therefore, it is essential to understand the evolving segments and trends affecting the market. This knowledge is key for navigating the rapid changes within the sector, ensuring that stakeholders are well-informed and prepared for the future, whether they are involved in manufacturing, investment, or healthcare delivery.

The Medical Device sector is experiencing a wave of technological advancements, with AI integration in diagnostics, wearable health monitors, and minimally invasive surgical tools revolutionising patient care. This has also given rise to personalised medicine, tailoring devices to individual patient needs and significantly improving treatment efficacy and outcomes. Navigating complex regulatory environments is crucial for ensuring device safety and efficacy, with compliance to standards from organisations like the Food and Drug Administration (FDA) and European Medicines Agency (EMA) being indispensable. For example, Medtronic and IBM Watson Health joined forces in 2020 to use AI for advanced diabetes care, promising to enhance management through AI-driven insights.

Global growth in the elderly population is also creating a demand for medical devices related to chronic disease management, mobility aids, and diagnostics, driving substantial industry expansion worldwide. Emerging markets are offering significant opportunities, and the convergence of digital health technologies, such as telemedicine and electronic health records, is shaping the future of medical devices.

In addition, there is also an increasing emphasis on value-based care, highlighting the need for devices that improve patient outcomes and reduce overall healthcare costs. Simultaneously, sustainability efforts are on the rise, with the sector aiming to develop more environmentally friendly practices and products. For example, in a recent development, GE Healthcare and Johnson & Johnson collaborated in 2023 to develop green technologies for medical imaging, with a focus on reducing the carbon footprint through energy-efficient designs and sustainable materials.

Market dynamics are shifting rapidly, with frequent mergers and acquisitions as companies expand their product offerings and market reach. There's also a growing presence in emerging markets with expanding healthcare infrastructure. Patient-centric design is a key priority, focusing on user-friendly devices that improve ease of use and patient compliance, alongside customisation to meet specific patient needs.

9. Fortune Business Insight, *Medical Devices Market to Surge at 6.3% CAGR over 2024 to 2032; Growing Incidence of Chronic Conditions to Boost Market Growth, April 2024; Malaysian Investment Development Authority, Malaysia poised to capture medical device manufacturing market*, 26 July 2024, <https://www.mida.gov.my/mida-news/malaysia-poised-to-capture-medical-device-manufacturing-market/>

Overview of the Malaysian Trends in the Medical Devices Sector

The Malaysian Medical Devices sector has witnessed significant growth and development in recent years. With a projected revenue expected to reach USD3.31 billion (RM15.2 billion) in 2024, surpassing the global growth rate.[7] This upward trend is fuelled by several key factors, including the presence of major international medical technology companies, a well-established manufacturing infrastructure, and a commitment to meeting global quality standards. Furthermore, Malaysia's strategic initiatives to position itself as a prime investment destination have opened the door to even greater expansion and opportunities within the sector.

The largest projected market volume in 2024 is for cardiology-based medical devices, estimated at USD525.5 million (RM2.42 billion). The sector is expected to maintain a steady annual growth rate (CAGR 2024-2029) of 7.51%, which is projected to lead to a market volume of USD4.75 billion (RM21.87 billion) by 2029, pulsing with continued expansion.[8]

Furthermore, Malaysia has solidified its position as one of the world's leading offshore manufacturing hubs for medical devices. With nearly 300 medical device manufacturing companies, primarily in Penang, such as B.Braun, Smith & Nephew, Boston Scientific, and Dexcom, the country is engaged in a wide range of activities, from regional headquarters and manufacturing, to R&D. This global competitiveness is a testament to Malaysia's robust manufacturing infrastructure and its alignment with global quality standards.[9]

According to the Malaysian Investment Development Authority (MIDA) and the Association of Malaysian Medical Industries (AMMI), Malaysia hosts manufacturing operations for 10 of the top 30 global medical technology companies, positioning the country as a prominent offshore manufacturing hub alongside Ireland, Puerto Rico, and Costa Rica.[10]

Efforts to advance Malaysia's Medical Devices sector have included training programmes benefiting 2,647 Malaysians and promoting the country as a prime investment destination. These initiatives have been instrumental in positioning Malaysia as a leading investment hub in the region and across Asia, attracting interest from major international medical device firms. Additionally, significant work has been done to mediate between these companies and local regulators, ensuring that quality standards and requirements align with global expectations.

The ratification of the Comprehensive and Progressive Agreement for Trans-Pacific Partnership (CPTPP) is expected to attract more foreign direct investments (FDI) in medical device manufacturing. With the global medical device market projected to reach USD886.80 billion (RM4.08 trillion) by 2032, further opportunities for the sector to expand are on the horizon.[11]

10. Statista, Medical Devices - Malaysia, <https://www.statista.com/outlook/hmo/medical-technology/medical-devices/malaysia#analyst-opinion>
11. Ibid
12. Malaysian Investment Development Authority, AMMI: Malaysia among world's top offshore manufacturing hubs for medical devices, 14 November 2022, <https://www.mida.gov.my/mida-news/malaysia-ranks-among-worlds-top-offshore-manufacturing-hubs-for-medical-devices-says-report/>
13. Malaysian Investment Development Authority, MIDA and AMMI Launched Medical Device Industry Status & Outlook 2021-2022 Report – Malaysia Dazzles as a World Leader in Medical Device, 14 November 2022, <https://www.mida.gov.my/media-release/mida-and-ammi-launched-medical-device-industry-status-outlook-2021-2022-report-malaysia-dazzles-as-a-world-leader-in-medical-device/>
14. Malaysian Investment Development Authority, Malaysia ranks among world's top offshore manufacturing hubs for medical devices, <https://www.mida.gov.my/mida-news/malaysia-ranks-among-worlds-top-offshore-manufacturing-hubs-for-medical-devices-says-report/>

> **We have to embrace AI, Digital and Green Economy which will help Malaysia's economy especially by increasing productivity, reducing costs and saving the environment. Overall, this makes us more competitive in the world by bringing more industries concerned about the natural environment and making sure we take care of our environment together with Malaysia's economy.**
>
> ***Mr Babu Krishnamoorthy, Sanmina***

To grasp the essence of the Medical Devices sector in Malaysia, it is important to understand that it comprises a diverse range of Multinational Corporations (MNCs), Public Listed Companies (PLCs), Small and Medium-sized Enterprises (SMEs), as well as a combination of global and local players.

A snapshot of Malaysia's Medical Devices sector[12]

GDP contribution (2022) — **RM2 billion**

Import / Export (2022) — Import **RM8.2 bil** | Export **RM31.8 bil**

Number of Employees (2020) — **70,000** skilled workers

- **Focus Areas on Medical Devices Industry:** The Medical Devices sector aims to expand its product offerings, attract FDIs and Domestic Direct Investments (DDI), develop supporting industries and services, and enhance institutional support for human resource development, R&D, and regulatory compliance.
- **Malaysia's Leadership in Rubber Products:** Malaysia has established itself as a global leader in rubber products, notably as the largest producer and exporter of rubber gloves, meeting 67% of the world's demand, and the second-largest producer of rubber thread.
- **Growth Drivers in Medical Devices:** The Medical Devices sector experienced significant growth due to an ageing population, increased health awareness and spending, a rise in chronic diseases, and a robust manufacturing ecosystem with Engineering and Manufacturing support (EMS).
- **Malaysia's Dominance in Consumables:** Malaysia has emerged as a significant manufacturer and exporter of medical consumables in Asia, supplying 80% of global catheters and 60% of rubber gloves. Notably, amidst the global pandemic, rubber glove production surged by 85%, from 55 billion pairs in 2019 to 102 billion pairs in 2020.
- **Top Offshore Manufacturing Hub:** Malaysia has positioned itself as a top offshore manufacturing hub for high-value medical devices, producing a diverse range of products such as orthopaedic implants, pacemakers, endoscopy equipment, advanced medical systems, and angioplasty stents and balloons.

15. Department of Statistics Malaysia (DOSM); Ministry of Investment, Trade, and Industry, New Industrial Master Plan 2030: Medical Devices Industry (NIMP 2030), 2023; Malaysia Investment Development Authority (MIDA), Malaysia's Medical Devices Industry: Immense Growth Potential, 2020

Malaysian Medical Devices Sector's State of Play

The largest sub-sector within the Medical Devices sector in Malaysia is the consumables. Malaysia is a leading global manufacturer of medical gloves, including both latex and nitrile gloves. This sub-sector has gained significance as the country's extensive production capabilities, strong export market, and significant role in global healthcare have increased and remain highly significant over time.

Consumables (Single-use Devices)	• Medical gloves • Personal Protective Equipment (PPE) • Catheters
Surgical Instruments, Implants and Clinical Devices	• Orthopaedic implants • Bone grafts • Dental implants
Health Equipment	• Ultrasound devices • Magnetic • Magnetic Resonance Imaging (MRI) • Blood management devices
Point of Care	• Pulse monitors • Urine dipsticks • Pregnancy tests • In-vitro diagnostics (IVD)
Non-minimal Invasive Product	• Blood glucose monitoring systems • Smart surgical devices or tools • Intervention devices
Medical Devices from Convergence of Technologies (e.g. Biological Science, Nanotechnology)	• Drug-eluting stent (DES)

Impacts of AI, Digital, and Green Economy on the Medical Devices Sector

A Challenges and Opportunities

Acknowledging and addressing the challenges posed by AI, Digital, and Green Economy in the Medical Devices sector is essential for their successful integration. By understanding and overcoming these obstacles, we can effectively navigate the sector's evolving landscape and capitalise on the opportunities that lie ahead.

Challenges

Skill Gaps:
Addressing the skill gaps in the workforce is one of the primary challenges. As the industry transitions towards AI, Digital, and sustainability for Green Economy, there will be a pressing need for reskilling and upskilling programmes to equip workers with the necessary competencies.

Investment Costs:
Implementing advanced technologies such as robotic automation, digital twin technology, and sustainable practices necessitates significant initial investment. Many companies, particularly SMEs, may need help securing the required funds and justifying the return on investment (ROI) due to the need for substantial upgrades to their manufacturing plants. In contrast, MNCs with sophisticated and upgraded facilities increasingly adopt AI and digital technologies in the Medical Devices sector to drive innovation, maintain a competitive edge, and achieve a faster return on investment.

Regulatory Compliance:
Keeping pace with evolving regulations related to AI, digital technologies, and environmental standards can be daunting. Navigating the complex regulatory landscapes requires a comprehensive approach to ensure that new technologies comply with safety, efficacy, and data security standards. Companies must invest in understanding and adhering to regulatory requirements, maintain robust quality management systems, and stay informed about evolving regulations and market dynamics. Effectively managing these aspects is crucial for successful product development, market-entry, and long-term success in the Medical Devices sector.

Cultural Resistance:
Organisational resistance to change can hinder the adoption of new technologies and sustainable practices. Encouraging a culture of innovation and openness to change will be crucial.

Opportunities

Enhanced Productivity and Innovation:
AI and digital technologies can automate routine tasks, analyse complex data patterns, and streamline processes, allowing healthcare professionals to focus more on patient care and research. Additionally, leveraging Green Economy practices such as sustainable sourcing and energy-efficient manufacturing reduces environmental impact and drives innovation by encouraging the development of eco-friendly medical devices and technologies.

Sustainability Leadership:
Malaysian Medical Device companies can establish themselves as leaders in sustainability by adopting Green Economy practices, which can attract eco-conscious consumers and investors.

Job Creation in New Domains:
While some traditional roles may become obsolete, new job opportunities will emerge in AI management, digital transformation, and sustainability. This creates a dynamic job market with diverse career pathways. For example, B. Braun is preparing its workforce for AI advancements by offering specialised training programmes, including workshops, online courses, and AI and machine learning certifications relevant to the Medical Devices sector. Additionally, the company is creating cross-functional teams that combine AI experts with existing employees to facilitate knowledge sharing and help integrate AI technologies into traditional workflows.

Global Competitiveness:
Embracing these trends will enhance the global competitiveness of Malaysian Medical Device manufacturers by fostering efficient, innovative, and sustainable practices that attract international partnerships and open up new markets. This will contribute to a steady annual growth rate (CAGR 2024-2029) of 7.51% and result in a market volume of USD4.8 billion (RM21.87 billion) by 2029.

B Impact of AI, Digital, and Green Economy

Artificial Intelligence

AI Trends

AI technologies are set to revolutionise the Medical Devices manufacturing process by enhancing efficiency, accuracy, and innovation, from research and development to production and quality control. AI, with its ability to reduce errors and improve quality control, will streamline operations and accelerate the time to market for new therapies. For the workforce, this means an increased demand for professionals skilled in AI and data analytics who are capable of developing and managing AI-driven systems. The Malaysian government has strategically emphasised AI development, recognising its potential to transform industries and enhance national competitiveness. The National Artificial Intelligence (AI) Roadmap 2021-2025, outlines Malaysia's roadmap for AI adoption across healthcare, agriculture, finance, and transportation sectors.

> "AI will have a more positive impact rather than negative in the long run because we will do things faster and accurately."
>
> ***Ms Marhanis, Molnlycke Healthcare Sdn. Bhd.***

AI Impact

AI significantly impacts the Medical Devices sector by enhancing diagnostic accuracy, personalising treatment, improving operational efficiency, and advancing research. However, it also brings regulation, data security, and skill development challenges that must be addressed to realise its full potential.

The impact of AI on the Medical Devices sector includes the following six (6) areas:	
Enhanced Diagnostic Accuracy and Precision	• **Improved Imaging Analysis:** AI algorithms analyse medical images (e.g., MRI, CT scans) with high accuracy, assisting radiologists in detecting abnormalities and diagnosing conditions earlier and more precisely.
Personalised Medicine	• **Tailored Treatments:** AI enables the analysis of large datasets to identify patterns and correlations, allowing personalised treatment plans based on individual patient data, including genetic information.
Operational Efficiency	• **Automation of Routine Tasks:** AI automates routine tasks such as data entry, scheduling, and inventory management, leading to more efficient operations and reducing administrative burdens. • **Predictive Maintenance:** AI-driven predictive maintenance models can proactively forecast equipment failures and schedule maintenance, reducing downtime and operational disruptions.
Improved Patient Monitoring	• **Real-Time Monitoring:** AI-powered wearable devices and remote monitoring tools provide continuous, real-time data on patient health, enabling early detection of potential issues and prompt intervention.
Regulatory and Compliance Challenges	• **Regulatory Adaptation:** The rapid evolution of AI technologies poses challenges for regulatory bodies to develop and enforce guidelines that ensure the safety and efficacy of AI-driven medical devices.
Training and Skill Development	• **New Skill Requirements:** Healthcare professionals must acquire new skills to effectively use AI-driven tools and interpret their outputs, necessitating ongoing training and education.

Digital

Digital Trends

The Digital trend encompasses integrating digital technologies into all areas of Medical Devices manufacturing. This includes IoT for real-time monitoring, blockchain for secure data management, and advanced predictive maintenance, and process optimisation software. As a result, there will be a growing need for workforce proficiency in digital tools and platforms, along with strong capabilities in cybersecurity, digital literacy, and systems integration.

Digital Health Blueprint: The Malaysian government introduced the Digital Health Blueprint to accelerate the adoption of digital technologies in healthcare, including the Medical Devices sector. The blueprint outlines strategies to enhance digital infrastructure, data interoperability, and cybersecurity to support digital healthcare services. MyDIGITAL is Malaysia's national digital transformation initiative. It includes provisions for enhancing digital infrastructure and capabilities across sectors, including healthcare and pharmaceuticals. It aims to create a conducive environment for digital innovation and economic growth.[13]

> **"Digitisation helps to streamline the manufacturing process, reduce human errors and improve productivity in the Medical Devices sector. This is the key trend that we need to embrace and we have to foresee the additional benefits to improve decision-making in the future by leveraging AI and digitalisation."**
>
> ***Mr. Ching Choon Siong, Association of Malaysia Medical Industries***

Digital Impact

Digital transformation is revolutionising the Medical Devices sector by enhancing device functionality, improving data management, enabling personalised care, streamlining manufacturing, aiding regulatory compliance, and expanding telehealth capabilities.

The impact of Digital on the Medical Devices sector includes the following six (6) areas:	
Enhanced Device Functionality and Innovation	• Digital technologies have led to the development of more sophisticated medical devices with enhanced functionality. These innovations include wearable health monitors, connected implantables, and advanced diagnostic tools that leverage digital capabilities to provide more precise and actionable data.
Improved Data Management and Analytics	• Integrating digital technologies improves data collection, management, and analysis. Medical devices now typically include digital interfaces that collect data in real time, facilitating better patient health monitoring and more informed decision-making.
Enhanced Patient Engagement and Personalisation	• Digital tools enable personalised medicine by tailoring treatments and devices to individual patient needs. Digital platforms improve patient engagement by offering real-time feedback and interactive features.
Streamlined Manufacturing and Supply Chain	• Digital technologies such as the IoT and automation are transforming manufacturing and supply chain processes in the Medical Devices sector. These advancements increase efficiency, reduce costs, and improve quality control.
Regulatory and Compliance Advances	• Digital tools and platforms help navigate regulatory requirements and ensure compliance. They also facilitate the documentation and reporting processes required for regulatory approvals and post-market surveillance.
Remote Monitoring and Telehealth Integration	• Digital technology's rise in remote monitoring and telehealth has expanded access to healthcare and allowed for continuous patient monitoring outside of traditional clinical settings.

Green Economy

Green Economy Trends

Malaysia has committed to various environmental sustainability goals, including reducing carbon emissions and increasing the use of renewable energy. To facilitate this transition, employees must undergo training on sustainable practices and environmental regulations.

The Government has launched policies and initiatives such as the National Green Technology Policy (NGTP) and the Malaysia Renewable Energy Policy. The NGTP promotes the adoption of green technologies and practices across various sectors, including Medical Devices and Health Care. The policy encourages Medical Device companies to implement energy-efficient technologies, reduce carbon footprints, and adopt sustainable manufacturing practices.

Green Investment Incentives: government agencies such as the Malaysian Investment Development Authority (MIDA) offer incentives and grants to encourage investments in green technologies and sustainable practices within the Medical Devices sector. These incentives support companies in adopting environmentally friendly processes and technologies.

16. MyDigital, *Malaysia Digital Economy Blueprint*, Economic Planning Unit, 2021

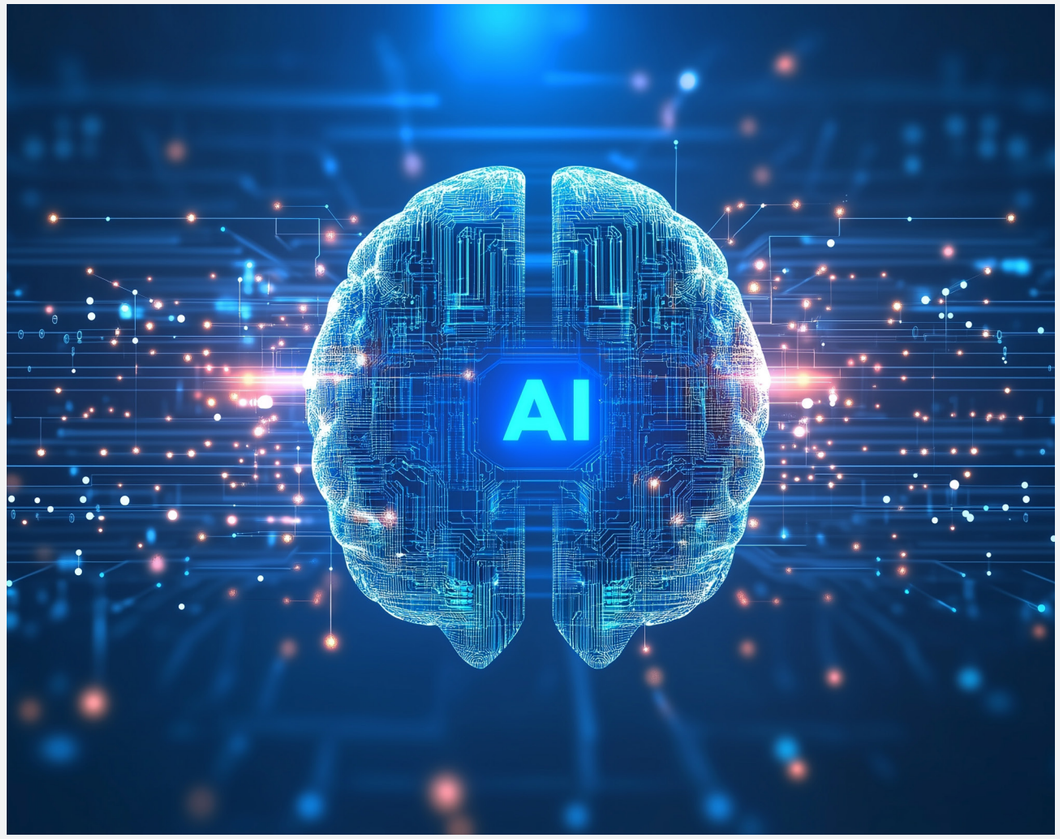
The Green Economy Impact

Green Economy significantly impacts the Medical Devices sector in several key areas:

Regulatory Compliance and Standards	• Stricter Regulations: Stricter regulations require manufacturers to comply with more rigorous environmental standards. • Eco-Design Requirements: Increasing pressure is being placed on designing devices that minimise resource use, reduce waste, and incorporate recyclable materials.
Sustainable Manufacturing Practices	• Resource Efficiency: The sector focuses on optimising material usage while reducing energy and water consumption. • Green Manufacturing Technologies: The adoption of cleaner production methods and renewable energy sources has increased.
Innovation and Development	• Eco-Friendly Materials: The sector has embraced biodegradable polymers and environmentally friendly packaging. • Green Technology Integration: The development of energy-efficient devices and technologies aimed at reducing waste and emissions is underway.
Market Demand and Consumer Preferences	• Increased Demand for Green Products: A growing demand for devices with a lower environmental impact is pushing manufacturers to adopt greener practices. • Competitive Advantage: Companies that embrace sustainability practices can gain a competitive edge and attract environmentally conscious customers.
Corporate Social Responsibility (CSR)	• Enhanced Reputation: Commitment to green practices enhances a company's reputation and its CSR profile. • Stakeholder Engagement: Companies engage with stakeholders to align their practices with broader sustainability goals and industry standards.

State of Trends Adoption

Artificial Intelligence



AI is transforming the Medical Devices sector in several significant ways:

Diagnostic Imaging:
AI algorithms analyse medical images from X-rays, MRIs, and CT scans with high accuracy, helping radiologists detect conditions like tumours and fractures early.

Predictive Analytics:
AI processes large volumes of patient data to forecast outcomes, aiding in creating personalised and effective treatment plans.

Robotic Surgery:
AI-powered surgical robots enhance precision and control during operations, offering real-time data and recommendations to improve surgical outcomes as well as reduce recovery times for the patient.

Wearable Devices:
AI is embedded in wearables like smartwatches and fitness trackers to monitor vital signs and activity levels, alerting users and healthcare providers to potential health issues.

Global

- **Medtronic** uses AI to predict maintenance needs and prevent equipment failures in their manufacturing facilities. AI algorithms analyse real-time data from machinery to forecast potential issues, allowing for timely maintenance and further reducing downtime.[14]
- **Philips Healthcare** employs AI to optimise its manufacturing processes by analysing production data in real-time. AI helps identify inefficiencies, improve operational efficiency, and ensure consistent product quality for medical imaging devices.[15]
- **Stryker** utilises AI-driven robotics and automation systems to produce orthopaedic implants and surgical instruments. AI enhances precision, reduces manual labour, and ensures consistency in manufacturing processes.[16]

Malaysia

- **Smith & Nephew Operations Sdn Bhd**
  AI in Predictive Maintenance: Smith & Nephew uses AI to monitor and predict the maintenance needs of their manufacturing equipment. By analysing data from sensors on their machines, AI algorithms can forecast potential failures before they happen, minimising downtime and extending the life of costly machinery. This predictive maintenance approach helps the company maintain high production efficiency and reduce costs associated with unexpected equipment breakdowns.[17]
- **Teleflex Medical Sdn Bhd**
  AI in Quality Control: Teleflex Medical incorporates AI in its quality control processes to ensure that all products meet stringent regulatory standards. AI-powered systems analyse real-time data from production lines, identifying defects or irregularities with greater accuracy and speed than traditional methods. This allows for immediate adjustments in the manufacturing process, thereby improving product consistency and reducing waste.[18]
- **Dexcom Malaysia**
  Dexcom Malaysia is actively developing an AI system called Auto VI to replace the manual inspection of sensors used in their continuous glucose monitoring (CGM) systems. This initiative aims to enhance the efficiency and accuracy of sensor quality checks, addressing the growing demand for diabetes management technologies. The move to implement AI-driven processes reflects Dexcom's commitment to innovation and its strategic goal to increase production capabilities, particularly in its new manufacturing facility in Penang, Malaysia, which is the company's first plant outside of the United States.[19]

17. Medtronik, *Medtronic to boost AI innovation with new platform introduction*, 22 March 2023, <https://news.medtronic.com/2023-03-22-Medtronic-to-boost-AI-innovation-with-new-platform-introduction
18. Siemens Healthineers, *Artificial intelligence in healthcare*, <https://www.siemens-healthineers.com/en-my/digital-health-solutions>
19. Medical Device Network, Stryker in artificial intelligence: theme innovation strategy, <https://www.medicaldevice-network.com/data-insights/stryker-in-artificial-intelligence-theme-innovation-strategy-2/>
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21. Veeva MedTech, *4 Takeaways from Teleflex on Quality Assurance and Regulatory Affairs Transformation*, <https://www.veeva.com/medtech/resources/4-takeaways-from-teleflex-on-quality-assurance-and-regulatory-affairs-transformation/>
22. change to: MIDA, US-Based Dexcom Chooses Malaysia To Open Its Third Continuous Glucose Monitoring System Manufacturing Site, 24 June 2020, <https://www.mida.gov.my/media-release/us-based-dexcom-chooses-malaysia-to-open-its-third-continuous-glucose-monitoring-system-manufacturing-site-2/>

Digital

Digitalisation in Medical Devices sector is driving significant changes in healthcare delivery and operational efficiency:

Electronic Health Records (EHRs):
Widespread adoption of EHRs enhances patient data management, improves data sharing, and fosters better coordination among healthcare providers.

Big Data and Analytics:
Advanced analytics utilise large datasets to offer insights for predictive analytics, refine treatment plans, and identify health trends.

Smart Manufacturing:
Integrating IoT and automation in manufacturing processes allows for real-time monitoring, improves quality control, and reduces defects in medical device production.

Global

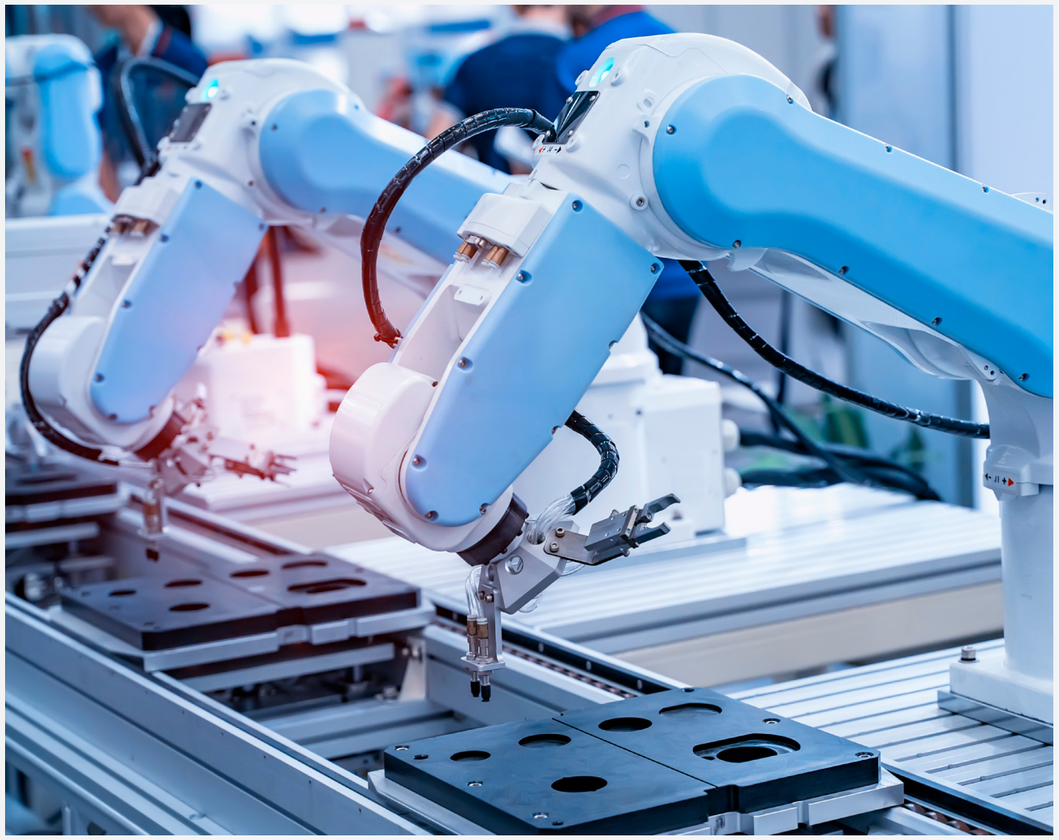
- **Medtronic** uses 3D printing to prototype complex medical devices, such as cardiac implants. This technology allows them to test and modify designs quickly before final production.[20]
- **Siemens Healthineers** employs automated manufacturing systems and IoT sensors to enhance the production of imaging equipment, ensuring high quality and efficiency.[21]
- **GE Healthcare** uses predictive analytics to monitor the condition of manufacturing equipment and schedule maintenance before failures occur, thereby improving equipment uptime and operational efficiency.[22]

Malaysia

- **B. Braun Medical Industries Sdn Bhd** has integrated digital tools into its supply chain management systems to enhance efficiency and transparency. By leveraging digital platforms, the company can monitor and manage its supply chain in real-time, ensuring that materials and products are tracked accurately from production to delivery. This digitalisation effort reduces lead times and minimises errors, improving customer satisfaction and operational efficiency.[23]
- **Dexcom (Malaysia)** has adopted Industry 4.0, utilising autonomous robots for storage and an automated spare parts management system. System integration is employed for transportation management, and Dexcom uses OSI PI as the data management solution to collect and store data from production tools, transforming it into real-time information.[24]

23. GlobalData, *Medtronic Digital Transformation Strategies Overview*, 10 May 2024, <https://www.globaldata.com/store/report/medtronic-plc-enterprise-tech-analysis/>
24. Siemens Healthineers, *Digital Solutions & Automation*, <https://www.siemens-healthineers.com/en-my/digital-health-solutions/artificial-intelligence-in-healthcare>
25. GE Healthcare, *Accelerating the digital transformation*, <https://www.gehealthcare.com/en-my/services/digital-solutions>
26. B. Braun, *Integrated Annual Report 2023*: Empowered by Technology, 2023
27. Stakeholders Engagement

Green Economy



The Green Economy is transforming the Medical Devices sector by prioritising sustainability and reducing environmental impact:

Eco-Friendly Materials:
The focus is on utilising sustainable, recyclable, and biodegradable materials in the manufacturing of medical devices.

Energy Efficiency:
Designing devices to consume less energy or utilise renewable sources helps lower their carbon footprint.

Reduced Waste:
Lean manufacturing and recycling programmes are implemented to minimise production waste, including reducing scrap and reusing components.

Lower Emissions:
Adopting cleaner technologies and processes aims to cut GHG emissions and other pollutants.

Water Conservation:
Water-saving technologies and practices are used in manufacturing to reduce water usage and wastewater production.

Global

- **Philips Healthcare's**
  'Sustainability Programme' focuses on reducing the environmental impact of its products and operations. The programme includes initiatives such as energy-efficient medical devices, waste reduction, and carbon neutrality goals. Philips aims to become carbon neutral by 2025 and has set targets for reducing the lifecycle environmental impact of its products.
- **Medtronic's**
  'Global Sustainability Strategy' emphasises on reducing GHG emissions, minimising waste, and conserving water. The strategy includes sustainable product development and improving energy efficiency in manufacturing. Medtronic is also working on circular economy practices and enhancing supply chain sustainability.
- **Johnson & Johnson's**
  'Health for Humanity Goals' in 2023 include a broad set of sustainability objectives, such as reducing GHG emissions, water usage, and waste. The company also focuses on sustainable sourcing, circular economy practices, and reducing the environmental impact of its medical devices and operations.

Malaysia

- **B. Braun Medical Industries Sdn Bhd** has been actively implementing green initiatives for several years. They focus on various aspects of sustainability, including water conservation, energy efficiency, and waste management. The company's ongoing commitment to environmental sustainability is well-documented through their continuous improvements in production processes and adherence to ISO 14001 environmental management standards.[25]
- **Smith & Nephew Operations Sdn Bhd** started their sustainability initiatives by opening their high-technology manufacturing facility in Batu Kawan Industrial Park, Penang, in June 2021. The facility was designed with a strong focus on sustainability, achieving zero-waste-to-landfill status four (4) years ahead of its target. The company has been recognised for its efforts by the United Nations Global Compact Network for Malaysia and Brunei in the category of SDG Benchmark 4: Zero Waste to Landfill and Incineration in December 2021.[26]
- **Top Glove,** primarily known for its glove production, has integrated sustainable practices into its operations. The company has invested in energy-efficient machinery and processes to minimise environmental impact, implemented waste recycling programmes, and they are striving to reduce the use of harmful chemicals in their manufacturing processes.[27]

28. B. Braun, *Decreasing our emissions*, <https://www.bbraunusa.com/en/about-us/responsibility/sustainability>
29. Smith+Nephew, *Sustainability*, <https://www.smith-nephew.com/en/who-we-are/sustainability>
30. Top Glove, *Sustainability Report 2023*, 2023

Chapter 4:
Key Findings

Overview of Roles and Skills

Value Chain

The impact study encompasses an in-depth analysis of all the key roles and components within the Medical Devices Sector value chain.

Research & Development	Components Manufacturing	Assembly / Production	Distribution/ Marketing	Post Sales Services
• Research and Development	• Engineering and Maintenance • Process Development / Manufacturing Science and Technology (MS&T)	• Production • Quality Assurance and Quality Control (QA & QC) • Regulatory, Compliance, and Security* • Site Management • Sustainability	• Distribution, Marketing, and Business Development	• Regulatory, Compliance, and Security*

*The roles under Regulatory, Compliance, and Security can be found in two (2) different areas of the Medical Devices value chain

Consolidated Roles and Skills in Medical Devices Sector

9 Job Clusters

Research and Development (14 job roles*)	**Engineering and Maintenance** (8 job roles*)	**Quality Assurance and Quality Control (QA&QC)** (5 job roles)	**Process Development / Manufacturing Science and Technology (MS&T)** (3 job roles*)
Production (14 job roles)	**Sustainability** (3 job roles)	**Regulatory, Compliance and Security** (1 job roles)	**Distribution, Marketing and Business Development** (7 job roles*)

Site Management
(2 job roles)

57 Job Roles
(*Including Emerging Roles)

23 Skills Clusters

(Categorised into 21 specific skill clusters and 2 basic skill clusters)

Specific Skills

Agile and Continuous Improvement (1 skill)	**Automation and Robotics** (1 skill)	**Branding, Sales, and Marketing** (1 skill)	**Business Development and Strategy** (1 skill)
Business Operation Management (1 skill)	**Customer, Vendor, and Stakeholder Management** (5 skills)	**Data Development and Implementation** (4 skills)	**Engineering and Maintenance** (9 skills)
General Business Management (4 skills)	**Health, Safety, and Environment (HSE)** (12 skills)	**Manufacturing and Production** (18 skills)	**Products and Services** (2 skills)
Project and Process Management (10 skills)	**Quality Management** (8 skills)	**Research and Development** (10 skills)	**Risk Management, Compliance, and Governance** (6 skills)
Software Development and Implementation (9 skills)	**Supply Chain and Logistics Management** (5 skills)	**Technical Design and Architecture** (1 skill)	**Technology Management** (1 skill)

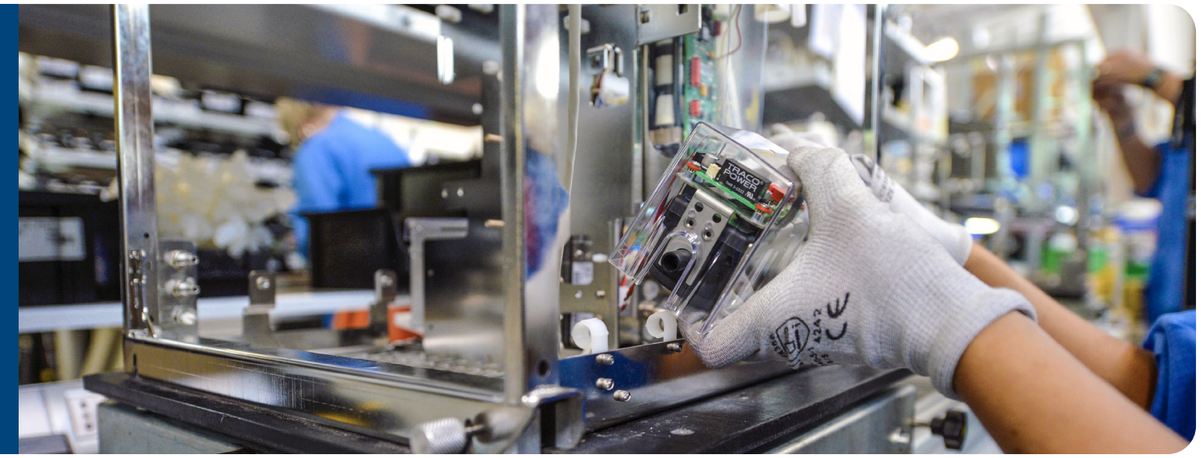
Warehouse & Inventory Management
(2 skills)

Basic Skills

Innovation and Delivery (9 skills)	**Social Intelligence** (5 skills)

125 Skills
Which comprises 111 Specific Skills and 14 Basic Skills

Job Clusters and Roles



In light of the increasing influence of AI, Digital, and Green Economy in the Medical Devices sector, it is important to understand the implications these changes can have on job roles and their respective categories within the sector. With ongoing developments, it's essential to examine how job responsibilities are evolving and how new roles are emerging as a response to these trends.

While some roles may undergo transformation or displacement, there will be new prospects, highlighting the significance of flexibility and continuous learning. Government and industry leaders must prioritise investment in educational and supportive programmes to navigate this shifting landscape effectively.

The increasing impact of AI, Digital, and Green Economy is bringing about major changes in Malaysia's Medical Devices workforce. Nine (9) job clusters, 57 roles, and 125 skills have been identified as essential for the Medical Devices sector.

Job Clusters	Roles	
Research and Development	1. Researcher (Material Scientist) 2. Research and Development Engineer 3. Electrical Engineer 4. Mechanical Engineer 5. Software Engineer 6. Medical Device Specialist 7. Biostatistician 8. Lab Technician	9. Clinical Trial Manager 10. Clinical Data Manager 11. Clinical Research Scientist 12. Data Scientist 13. Patent Engineer / Intellectual Property Specialist 14. Telehealth and Remote Monitoring Specialist*
Engineering and Maintenance	1. Engineering and Maintenance Director 2. Engineering and Maintenance Manager 3. Engineering and Maintenance Engineer 4. Engineering and Maintenance Supervisor	5. Engineering and Maintenance Technician 6. Manufacturing Engineer 7. System Integration Engineer 8. AI Diagnostics Engineer*
Process Development / Manufacturing Science and Technology (MS&T)	1. Process Development / MS&T Director 2. Process Development / MS&T Manager	3. Process Development / MS&T Engineer
Production	1. Production Director 2. Production Manager 3. Production Executive 4. Production Team Supervisor 5. Production Engineer 6. Production Technician 7. Validation Engineer	8. Calibration Engineer 9. Molding Engineer 10. Assembler (Production Operator) 11. Packaging Engineer 12. Production Planner 13. Demand Planner 14. Material Planner
Quality Assurance and Quality Control (QA & QC)	1. Quality Assurance & Quality Control Manager 2. Quality Assurance Executive 3. Quality Assurance Technician	4. Quality Control Engineer 5. Quality Control Inspector
Regulatory, Compliance and Security	1. Regulatory and Compliance Officer	
Site Management	1. Site Director / Head	2. Site Maintenance Engineer
Sustainability	1. Sustainability Manager 2. Sustainability Specialist	3. Environment, Health and Safety Manager
Distribution, Marketing and Business Development	1. Warehouse Manager 2. Warehouse Associate / Assistant / Material Handler 3. Warehouse Inventory Manager 4. Business Development Manager/ Account Programme Manager	5. Procurement Executive 6. AI Digital Marketing* 7. Cloud Computing Engineer*

*Emerging Roles

Skills Clusters and Skills

Skills Category	Skills Clusters	
BASIC SKILLS Essential skills for a person to be fit for a job.	**Innovation and Delivery**	
	• Adaptability & Resiliency	• Critical Thinking
	• Business Acumen	• Innovative Thinking
	• Change Management	• Learning Agility
	• Cognitive Skills	• Sustainability Awareness
	• Digital & AI Fluency	
	Social Intelligence	
	• Coaching & Mentoring	• Communication
	• Conflict Management	• Empathy
	• Teamwork & Collaboration	
SPECIFIC SKILLS Skills relating to a specific task or situation. It involves both understanding and proficiency in such specific activity that involves methods, processes, procedures, or techniques.	**Agile and Continuous Improvement**	
	• Continuous Improvement	
	Automation and Robotics	
	• Automated Operation Monitoring	
	Branding, Sales, and Marketing	
	• Sales Target Management	
	Business Development and Strategy	
	• Systems Thinking	
	Business Operation Management	
	• Production Planning and Scheduling	
	Customer, Vendor, and Stakeholder Management	
	• Vendor Management	• Global Perspective
	• Business Performance Management	• Stakeholder Management
	• Customer Relationship Management	

Skills Category	Skills Clusters	
SPECIFIC SKILLS Skills relating to a specific task or situation. It involves both understanding and proficiency in such specific activity that involves methods, processes, procedures, or techniques.	**Data Development and Implementation**	
	• Big Data Analytics	• Data Validation
	• Data Management	• Statistical Analytics
	Engineering and Maintenance	
	• Automated Equipment and Control Systems Configuration	• Equipment and Systems Testing
	• Automated Process Design	• Facility Maintenance
	• Engineering Drawing	• Installation and Assembly
	• Equipment and Systems Repair	• Predictive Maintenance
		• Preventive Maintenance
	General Business Management	
	• Budget Management	• Cost Management
	• Business Networking	• Resource Management
	Health, Safety, and Environment (HSE)	
	• Chemical Risk Management	• Sustainable Business Practices
	• Eco-Design Principles	• Sustainable Landscapes
	• Enviromental Remediation	• Sustainable Manufacturing
	• Environmental Awareness	• Sustainable Utilities Management
	• Health, Safety, and Environment Procedures Implementation	• Waste Management
	• Renewable Energy	• Workplace Safety and Health
	Manufacturing and Production	
	• Bioreactor Operation and Control	• Manufacturing Equipment Operation and Control
	• Calibration	• Manufacturing Process Management
	• Chromatography Equipment Operation and Control	• Manufacturing Systems Operation and Control
	• Cleaning and Sterilising	• Materials Management
	• Computer Systems Validation	• Materials Selection and Expertise
	• Facility Design	• Medical Imaging and CAD Modeling
	• Good Manufacturing Practices Implementation	• Packaging Validation
	• Green Manufacturing Design and Implementation	• Raw Materials and Utilities Testing
	• Knowledge of ISO standard competencies	• Troubleshooting and Maintenance
	Products and Services	
	• Marketing	• Product Design and Development

Skills Clusters and Skills (Continue)

Skills Category	Skills Clusters	
SPECIFIC SKILLS Skills relating to a specific task or situation. It involves both understanding and proficiency in such specific activity that involves methods, processes, procedures, or techniques.	**Project and Process Management**	
	• Automated Process Control • Crisis Management • Manufacturing Process Optimisation • Process Analytical Technology Implementation • Process Modelling	• Process Monitoring • Production Optimisation • Project Management • Supply Chain Sustainability • System Simulation and Verification
	Quality Management	
	• Biorisk Management • Cleanliness Testing • Document Control • Packaging Testing	• Process Validation • Product Testing • Quality Assurance Management • Quality Control Management
	Research and Development	
	• Analytical Method Validation • Bioanalytics • Clinical Assessment • Clinical Operations • Clinical Report Writing	• Clinical Study Design • Ethical Reporting • Patent Inventions • Research and Information Synthesis • Technical Report Writing
	Risk Management, Compliance, and Governance	
	• Audit Management • Business Continuity Management • Global Regulatory Affairs	• Hazard and Risk Identification and Management • Regulatory Compliance • Risk Management
	Software Development and Implementation	
	• Encryption and Cryptography • Information Security • Malware Analysis • Network Security • Programming, Coding and Scripting	• Security Governance • Software Design • Threat Intelligence and Detection • Vulnerability Assessment and Penetration Testing
	Supply Chain and Logistics Management	
	• Delivery Management • Order Fulfilment and Returns Processing • Supplier Performance	• Supplier Sourcing • Supply Chain Operational Costing

Skills Category	Skills Clusters	
SPECIFIC SKILLS Skills relating to a specific task or situation. It involves both understanding and proficiency in such specific activity that involves methods, processes, procedures, or techniques.	**Technical Design and Architecture**	
	• Design Optimisation	
	Technology Management	
	• Machine Learning Models	
	Warehouse & Inventory Management	
	• Inventory Control Management	• Warehouse Facility Management

In-Demand Skills

The in-demand skills in the Medical Devices sector include:

Areas	Skills
AI & DIGITAL	• Automated Process Control • Big Data Analytics • Good Manufacturing Practices Implementation • Automated Process Design • Process Analytical Technology Implementation • Analytical Method Validation
GREEN ECONOMY	• Health, Safety and Environment Procedures Implementation • Green Manufacturing Design and Implementation • Sustainable Manufacturing • Waste Management

Below are the non-exhaustive skills relevant to the Medical Devices sector:

Process Monitoring	**Project Management**	**Regulatory Compliance**
Risk Management	**Technical Report Writing**	**Hazard and Risk Identification and Management**
Business Continuity Management	**Continuous Improvement**	

Role and Skills Analysis by Impact Level

The impact study for the Medical Devices sector has unveiled 57 critical roles. Among these, 53 are established roles that serve as the backbone of industry standards and operational efficiency. Additionally, the analysis highlights four (4) emerging roles poised to be the vanguard of future advancements and innovations, steering the sector toward new frontiers of excellence.

Impact Assessment on 53 Existing Roles in the Medical Devices Sector

	High	Medium	Low	Emerging
AI/Digital	• **High opportunity** to **automate** • **Low human intervention**	• **High opportunity** to **automate** • **High human intervention**	• **Low opportunity** to **automate** • **High or low human intervention**	
Green Economy	• **Job no longer required** due to impact to environment • **May or may not** have **opportunity to diversify**	• **Job still required** despite impact to environment • **Opportunity to diversify exist**	• **Job still required** despite impact to environment • **No opportunity to diversify**	New job positions created due to technological advancements, sector trends, and societal changes help organisations drive innovation, adopt sustainable practices, and stay competitive and compliant with evolving regulations and market demands.
Outcome	**Roles facing convergence or displacement** Need to pivot to adjacent role and reskill	**Roles are evolving** Need to upskill to deliver beyond what would traditionally be expected	**Roles not severely impacted** Need to continue improving to keep self relevant	
	6 Roles	39 Roles	8 Roles	4 Roles
Proportion of Roles	11%	74%	15%	

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

Building on this, under highly impacted roles, AI, Digital, and Green Economy are transforming Medical Devices sector roles by boosting efficiency, accuracy, and sustainability. Advanced data analysis tools, automation, and digital technologies

that enhance testing, predictive maintenance, and manufacturing processes significantly shape these critical roles. Moreover, these technologies promote eco-friendly practices, improve assembly precision, and leverage AI-driven systems for quality assurance, aligning with the study's focus on equipping the workforce with future-ready skills.

On the other hand, some roles in the Medical Devices sector are categorised under medium and low impacted roles, primarily due to their specialised nature, slower adoption of new technologies, and reliance on human-centric skills. Additionally, existing infrastructure and legacy systems may limit the immediate integration of these advancements. Roles focused on niche functions or strict regulatory compliance may also experience less direct change, maintaining a balance between innovation and the current operational structure.

Below is an overview of the impact assessment on 53 existing roles across the Medical Devices sector, with six (6) highly impacted roles, 39 medium impacted roles, eight (8) low impacted roles, and four (4) emerging roles.

An Overview of the Impact Assessment on 53 Existing Roles across the Medical Devices Sector

HIGH

6 Roles

1. Biostatisticians
2. Lab Technician
3. Engineering and Maintenance Supervisor
4. Production Executive
5. Assembler (Production Operator)
6. Quality Assurance Technician

MEDIUM

39 Roles

1. Research and Development Engineer
2. Electrical Engineer
3. Mechanical Engineer
4. Software Engineer
5. Medical Device Specialist
6. Clinical Trial Manager
7. Clinical Data Manager
8. Data Scientist
9. Patent Engineer / Intellectual Property Specialist
10. Engineering and Maintenance Director
11. Engineering and Maintenance Manager
12. Engineering and Maintenance Engineer
13. Engineering and Maintenance Technician
14. Manufacturing Engineer
15. System Integration Engineer
16. Process Development / MS&T Manager
17. Process Development / MS&T Engineer
18. Production Director
19. Production Manager
20. Production Team Supervisor
21. Production Engineer
22. Production Technician
23. Validation Engineer
24. Calibration Engineer
25. Production Planner
26. Demand Planner
27. Material Planner
28. Quality Assurance Executive
29. Quality Control Engineer
30. Quality Control Inspector
31. Site Maintenance Engineer
32. Sustainability Manager
33. Sustainability Specialist
34. Warehouse Manager
35. Warehouse Associate / Assistant / Material Handler
36. Warehouse Inventory Manager
37. Business Development Manager / Account Manager /Programme Manager
38. Procurement Executive
39. Packaging Engineer

LOW

8 Roles

1. Researcher (Material Scientist)
2. Clinical Research Scientist
3. Process Development / MS&T Director
4. Moulding Engineer
5. Quality Assurance & Quality Control Manager
6. Regulatory and Compliance Officer
7. Site Director /Head
8. Environment, Health and Safety Manager

EMERGING

4 Roles

1. AI Diagnostics Engineer
2. Telehealth and Remote Monitoring Specialist
3. AI Digital Marketing
4. Cloud Computing Engineer

Highly Impacted Roles and Career Pathways

Shifts in consumption patterns and the rise of automation technology primarily influence highly impacted roles. These roles, while significantly impacted, present opportunities for transition into other in-demand positions. As AI plays an increasingly pivotal role in drug discovery and manufacturing, the demand for professionals skilled in data analysis, machine learning, and AI algorithm development is growing rapidly. Employees in these highly impacted roles must adapt by acquiring the necessary skills to leverage AI tools, enabling them to analyse large datasets, predict outcomes, and optimise processes more efficiently. This shift not only reshapes individual career pathways but also enhances the overall competitiveness of the sector.

As digitalisation permeates the sector, there is a growing need for digital literacy across all workforce levels. Cybersecurity skills become paramount to protect sensitive data from breaches. Developing and implementing green technologies, such as renewable energy sources and biodegradable materials, demands innovation and technical skills. This includes R&D capabilities focused on creating sustainable alternatives to traditional manufacturing processes, paving the way for a greener future.

Case Studies for Highly Impacted Roles

Roles	Impact and Case Studies
Biostatisticians	AI can handle vast amounts of data more efficiently than traditional methods. The technology assists biostatisticians in analysing intricate datasets. AI algorithms can uncover patterns and relationships that may elude human analysis alone. AI techniques, such as machine learning, can improve predictive modelling in biostatistics. This includes better predictions of disease outcomes, treatment responses, and patient risks, leading to more personalised and effective healthcare solutions. AI can automate repetitive and time-consuming tasks, such as data cleaning, data entry, and preliminary statistical analyses. • **Boston Scientific USA:** Boston Scientific incorporates AI into its medical devices to enhance patient monitoring and treatment precision. For example, their AI-driven heart rhythm management devices analyse patient data to optimise therapy, reducing the need for manual statistical oversight.[28] • **Medtronic Ireland:** Medtronic has developed several AI-driven solutions, such as its AI-powered insulin pump and continuous glucose monitoring systems. These devices use AI to provide real-time insulin delivery and glucose management recommendations, improving patient outcomes and reducing the need for biostatisticians to analyse data manually.[29]
Lab Technician	AI replaced specific routine tasks traditionally performed by lab technicians. It also elevated the role by requiring technicians to acquire new skills in AI integration, robotics maintenance, and data interpretation. This example underscores how AI adoption in the Medical Devices sector can lead to job role transformations rather than outright displacement, highlighting the evolving nature of work in response to technological advancements. In addition, Digital Laboratory Information Management Systems (LIMS) allows for seamless data management, tracking, and sharing, improving the efficiency of laboratory operations and ensuring data integrity. • **Siemens Healthineers Germany:** Siemens Healthineers applies AI to automate various diagnostic imaging and laboratory testing aspects. For example, AI is used in imaging systems to automate image analysis and laboratory instruments to manage and interpret test results, thus minimising the need for lab technicians to perform manual oversight.[30] • **Philips Healthcare Netherland:** Philips integrates AI into its diagnostic systems, such as imaging and patient monitoring. AI enhances automation in interpreting diagnostic results and managing data, which can decrease the need for lab technicians to process them manually.[31]

31. Boston Scientific, Cardiac Rhythm Management, <https://www.bostonscientific.com/en-US/about-us/core-businesses/rhythm-management.html>
32. Medtronic, AI is unlocking the future of health tech, <https://www.medtronic.com/us-en/our-company/ai-healthcare-technology.html>
33. Siemens Healthineers, Artificial Intelligence in Radiology: Empowering clinical decisions with AI, <https://www.siemens-healthineers.com/medical-imaging/digital-transformation-of-radiology/ai-in-radiology>
34. Philips, Philips highlights AI-powered integrated diagnostic approach at ECR 2023, 1 March 2023, <https://www.philips.com/a-w/about/news/archive/standard/news/press/2023/20230301-philips-highlights-ai-powered-integrated-diagnostic-approach-at-ecr-2023.html>

Roles	Impact and Case Studies
Engineering and Maintenance Supervisor	AI can simplify the supervisory role, taking on tasks such as setting production targets, driving continuous improvement in manufacturing, budgeting, and operational management. These tasks, once manual, are now efficiently generated by AI. • **Medtronic Ireland:** Medtronic has embraced digital transformation in its manufacturing and maintenance processes. It uses predictive maintenance systems powered by AI to monitor equipment health and predict potential failures before they occur. This advancement reduces the need for traditional maintenance supervision by enabling more proactive and data-driven maintenance strategies.[32] • **Boston Scientific USA:** Boston Scientific utilises advanced analytics and AI for equipment maintenance and management. Their digital systems help monitor equipment performance and predict maintenance needs, reducing reliance on engineering maintenance supervisors' manual oversight.[33]
Production Executive	AI significantly impacts this role, as non-managerial production personnel can greatly benefit from AI-driven automation and optimisation of production tasks. The impact is substantial due to AI's automation and optimisation capabilities. • **Philips Healthcare Netherland:** Philips uses automation and AI to enhance its production capabilities. Their digital solutions facilitate real-time monitoring and adjustment of production lines, helping to optimise workflow and reduce the role of traditional production executives in managing these processes.[34] • **Stryker Netherland:** Stryker has integrated smart manufacturing technologies and AI into its production facilities. These technologies, including automated production lines and AI-powered process optimisation tools, significantly reduce the need for manual intervention by production executives. This shift allows the executives to focus on more strategic tasks, relieving them of repetitive management tasks.[35]

35. Medtronic, AI is unlocking the future of health tech, <https://www.medtronic.com/us-en/our-company/ai-healthcare-technology.html>
36. Boston Scientific, Advancing Science for Life: 2022 Performance Report, 2022
37. Philips, Philips highlights AI-powered integrated diagnostic approach at ECR 2023, 1 March 2023, <https://www.philips.com/a-w/about/news/archive/standard/news/press/2023/20230301-philips-highlights-ai-powered-integrated-diagnostic-approach-at-ecr-2023.html>
38. Medical Device Network, Stryker in artificial intelligence: theme innovation strategy, 18 March 2024, <https://www.medicaldevice-network.com/data-insights/stryker-in-artificial-intelligence-theme-innovation-strategy-2/>

Roles	Impact and Case Studies
Assembler (Production Operator)	Modern machines and robotics have advanced sensors, AI, and machine learning algorithms. This enables them to perform complex tasks with high precision and efficiency. They can handle everything from assembling products to performing quality control. In manufacturing, robotic process automation (RPA) systems are programmed to handle repetitive and predictable tasks traditionally performed by humans. These systems can work around the clock without fatigue, leading to higher productivity and consistency. • **Medtronic Ireland:** Medtronic has been at the forefront of integrating AI and robotics in its manufacturing processes. For instance, they have utilised robotic systems to automate the assembly of specific medical devices, such as cardiac and neurological implants. These systems are designed to handle repetitive tasks with high precision, reducing the need for manual assemblers.[36] • **Boston Scientific USA:** Boston Scientific has also implemented AI-driven automation in its manufacturing facilities. Robotic systems equipped with AI handle assembly tasks for various devices, including stents and catheter systems. This approach helps improve production efficiency and maintain high-quality standards.[37]
Quality Assurance Technician	AI's role in quality assurance is significant, even for non-managerial personnel. AI-driven validation and data collection can provide reliable and consistent results, enhancing the quality assurance process. The potential of AI-driven automation and analysis of quality data is significant. It can revolutionise the quality control process, providing more accurate and reliable results. • **Siemens:** Siemens has adopted AI and digital solutions for quality control in their manufacturing processes. AI algorithms analyse data from production lines, identify anomalies, and ensure that devices meet stringent quality standards. This integration helps reduce the need for manual inspection and increases the reliability of quality assurance.[38] • **GE Healthcare USA:** GE Healthcare has implemented AI-driven inspection systems that use machine learning and computer vision to automate the quality control of medical devices. These systems can detect defects or deviations from quality standards with high precision, thus reducing the reliance on manual QA technicians.[39]

39. Medtronik, Medtronic to boost AI innovation with new platform introduction, 22 March 2023, <https://news.medtronic.com/2023-03-22-Medtronic-to-boost-AI-innovation-with-new-platform-introduction
40. Warren Wang, How is AI Transforming Healthcare?, Boston Scientific, 14 March 2019, <https://news.bostonscientific.com/warren-wang-how-is-ai-transforming-healthcare>
41. Siemens, Artificial Intelligence in Industry, <https://www.siemens.com/global/en/products/automation/topic-areas/artificial-intelligence-in-industry.html>
42. GE Healthcare, GE HealthCare Accelerates AI Innovation with Healthcare-Specific Foundation Models Powered by NVIDIA, 18 March 2024, <https://www.gehealthcare.com/about/newsroom/press-releases/ge-healthcare-accelerates-ai-innovation-with-healthcare-specific-foundation-models-powered-by-nvidia>

Highly Impacted Roles Career Pathways

Roles

BIOSTATISTICIANS

Key Responsibilities:
Responsible for designing and analysing clinical studies related to medical devices, applying statistical methods to interpret data, and collaborating with research teams to ensure rigorous study protocols. The role also involves providing insights to support regulatory submissions and product development, developing statistical models, validating results, and effectively communicating findings to stakeholders.

Examples of Additional Skills Required and Analysis

AI SKILLS

1. **Machine Learning Algorithms:**
Learn supervised learning (regression, classification), unsupervised learning (clustering, dimensionality reduction), and ensemble methods (random forests, gradient boosting). Analyse complex biological data (e.g., genomics, proteomics) to identify patterns, predict outcomes, and make accurate inferences.

2. **Deep Learning and Neural Networks:**
Gain proficiency in frameworks (e.g., TensorFlow, PyTorch) and understand neural network architectures (e.g., convolutional, recurrent). Handle and interpret large volumes of unstructured data (e.g., medical imaging, genetic sequences) for advanced features like image recognition and sequence prediction.

DIGITAL SKILLS

1. **Data Management and SQL:**
Proficiency in using SQL (Structured Query Language) for managing and querying large datasets and understanding data warehousing concepts. Efficiently extract, manipulate, and manage large volumes of data from relational databases, which is crucial for handling complex datasets in research and clinical trials.

2. **Data Visualisation Tools:**
Expertise in using advanced data visualisation tools and software (e.g., Tableau, Power BI, R's ggplot2) to create interactive and insightful visual representations of data.

GREEN SKILLS

1. **Environmental Science and Sustainability Knowledge:**
Knowledge of GHG, sources of carbon emissions, and their environmental impact. Familiarity with sustainable practices in various industries, including energy efficiency, waste reduction, and resource conservation.

Possible Roles for Transition within the Sector

Data Scientist

Researcher (Material Scientist)

Packaging Engineer

Data Analyst

Possible Roles for Transition into Other Sectors

Data Scientist
Sector:
ICT

Data Scientist
Sector:
Global Business Services

Researcher
Sector:
Pharmaceutical Manufaturing

Highly Impacted Roles Career Pathways

(Continue)

Roles	Examples of Additional Skills Required and Analysis			Possible Roles for Transition within the Sector
	AI SKILLS	DIGITAL SKILLS	GREEN SKILLS	
LAB TECHNICIAN **Key Responsibilities:** Responsible for performing routine laboratory tests and experiments for medical device development, preparing samples and reagents, maintaining laboratory equipment, ensuring compliance with safety and quality standards, and accurately documenting test results. This role supports research and development teams by providing timely data and insights to facilitate product testing and evaluation.	1. **Big Data Analysis:** Possessing these skills are integral for lab technicians to enhance experimental outcomes, improve research efficiency, foster teamwork and collaboration, ensure compliance, and drive innovation in scientific and technical disciplines. Acquiring and developing these skills empower lab technicians to navigate the complexities of modern data-driven research environments effectively. 2. **Machine Learning Awareness:** Having such awareness enables medical devices professionals to harness data-driven insights, enhance decision-making, drive innovation, and improve patient outcomes. By integrating machine learning into drug discovery, development, and healthcare delivery, the Medical Devices sector cannot just achieve advancements but significant advancements in therapeutic innovation and personalised medicine.	1. **Laboratory Information Management Systems (LIMS):** This skill is essential in the Medical Device sector for the purpose of enhancing data management, compliance, operational efficiency, and teamwork and collaboration across laboratory functions.	1. **Environmental Health and Safety (EHS):** EHS is fundamental for medical devices lab technicians to promote workplace safety, ensure regulatory compliance, protect the environment, and uphold ethical standards in laboratory operations. By integrating EHS principles into their daily practices and decision-making, lab technicians contribute to a safe, healthy, and sustainable work environment conducive to scientific excellence and innovation in medical devices research and development. 2. **Sustainable Laboratory Practices:** Such practices are essential for medical devices technicians to mitigate environmental impact, enhance operational efficiency, comply with regulations, and uphold corporate responsibility. Medical device companies can achieve long-term environmental, social, and economic benefits by integrating sustainability into laboratory operations and decision-making processes while contributing to global sustainability goals.	 Data Scientist  Researcher (Material Scientist)  Packaging Engineer  Data Analyst **Possible Roles for Transition into Other Sectors**  **Quality Control Laboratory Analys** Sector: Pharmaceutical Manufacturing  **Clinical Trial Administrator (CTA)** Sector: Pharmaceutical Manufacturing

Highly Impacted Roles Career Pathways

(Continue)

Roles

ENGINEERING AND MAINTENANCE SUPERVISOR

Key Responsibilities:
Responsible for overseeing the daily operations of the engineering and maintenance teams within the medical device manufacturing facility. This role involves managing staff, coordinating maintenance schedules, and ensuring compliance with safety and regulatory standards. The Supervisor monitors equipment performance, facilitates troubleshooting and repairs, and implements preventive maintenance programmes. Additionally, this position supports continuous improvement initiatives and collaborates with cross-functional teams to enhance operational efficiency and productivity.

Examples of Additional Skills Required and Analysis

AI SKILLS

1. **Predictive Maintenance:**
Predictive maintenance skills enhanced with AI are indispensable for post-production engineers in the Medical Devices sector. By harnessing AI's capabilities to predict equipment failures, optimise maintenance schedules, ensure regulatory compliance, and enhance operational efficiency, engineers can contribute to reliable and efficient medical devices manufacturing processes that prioritise product quality, safety, and sustainability.

2. **Data Analytics:**
The power of AI-driven data analytics is a game-changer for post-production engineers in the Medical Devices sector. It empowers them to leverage data-driven insights, optimise processes, ensure quality and compliance, and drive continuous improvement and innovation. Harnessing AI-driven data analytics contributes to efficient and effective medical devices manufacturing operations that meet regulatory standards, exceed customer expectations, and drive business success.

DIGITAL SKILLS

1. **Digital Twin Technology:**
This technology empowers post-production engineers in the Medical Devices sector to optimise manufacturing processes, ensure product quality and compliance, mitigate risks, and drive continuous improvement and innovation. By harnessing the capabilities of Digital Twins, engineers are able to enhance operational efficiency, reduce costs, and maintain a competitive advantage in the evolving medical devices manufacturing landscape.

2. **Industry 4.0 Technologies:**
In the face of rapid changes, companies and industrial processes must be ready to adapt or risk falling behind their competitors. Industry 4.0 (IR 4.0) offers insights into the Medical Devices sector, and the findings explore current applications of IR 4.0 technologies, identifying key areas where they have been implemented. The research further recommends best practices for integrating IR 4.0 technologies into operations and processes, while also addressing regional factors, challenges in implementation, and relevant concepts and theories to guide future studies.

GREEN SKILLS

1. **Sustainable Process Optimisation:**
This provides the ability to optimise post-production processes to minimise waste, reduce energy consumption, and lower the carbon footprint.

2. **Energy Management:**
Skills in monitoring and managing energy use in post-production facilities is key to identify energy savings and efficiency improvements opportunities.

Possible Roles for Transition within the Sector

Calibration Engineer

Electrical Engineer

Moulding Engineer

Possible Roles for Transition into Other Sectors

Engineering and Maintenance Supervisor
Sector:
Pharmaceutical Manufacturing

Engineering and Maintenance Engineer
Sector:
Pharmaceutical Manufacturing

Highly Impacted Roles Career Pathways

(Continue)

Roles	Examples of Additional Skills Required and Analysis			Possible Roles for Transition within the Sector
	AI SKILLS	DIGITAL SKILLS	GREEN SKILLS	
PRODUCTION EXECUTIVE **Key Responsibilities:** Responsible for supporting the day-to-day operations of the manufacturing process within the medical device facility. This role involves assisting in the coordination of production schedules, monitoring workflow, and ensuring compliance with quality and safety standards. The Executive collaborates with production teams to identify and resolve issues, track performance metrics, and implement process improvements. Additionally, this position assists with inventory management and reporting, contributing to the overall efficiency and effectiveness of production operations.	1. **Machine Learning Oversight:** Knowledge of machine learning applications that forecast demand, optimise production schedules, and reduce waste. 2. **AI in Quality Control:** Familiarity with AI tools that automate quality control checks, detect anomalies, and ensure compliance with regulatory standards.	1. **Industry 4.0 Technologies:** Familiarity with Industry 4.0 concepts, including IoT devices, to monitor and control real-time post-production operations. 2. **Digital Workflow Management:** Proficient in managing digital workflows and ensuring seamless communication between digital platforms and production systems.	1. **Sustainability Reporting:** Ability to report on sustainability metrics, set targets for improvement, and communicate progress to stakeholders. 2. **Energy Efficiency Programmes:** Implementing energy efficiency programmes to reduce the carbon footprint and operational costs associated with production.	**Production Team Supervisor** **Production Engineer** **Production Planner** **Possible Roles for Transition into Other Sectors** **Production Technician** Sector: Chemical **Production Technician** Sector: Pharmaceutical Manufacturing

Highly Impacted Roles Career Pathways

(Continue)

Roles

Examples of Additional Skills Required and Analysis

Possible Roles for Transition within the Sector

ASSEMBLER (PRODUCTION OPERATOR)

Key Responsibilities:
Responsible for assembling components and subassemblies in the manufacturing of medical devices. This role involves following detailed work instructions, performing quality checks, and ensuring compliance with safety and regulatory standards. The Assembler works closely with team members to maintain efficient production flow, troubleshoot assembly issues, and accurately document production activities. Additionally, this position supports continuous improvement efforts by providing feedback on processes and suggesting enhancements to optimise efficiency and product quality.

AI SKILLS

1. **Understanding and Using AI-Powered Quality Control Systems:**
   Having this knowledge provides the ability to interact with and operate AI-based quality control systems. These systems often use computer vision and machine learning algorithms to detect defects or anomalies in real time during the assembly process. Being adept at using these systems helps ensure high product quality and minimises manual inspection efforts.

2. **Basic Data Analysis and Interpretation:**
   This skill provides the ability to understand and interpret data reports generated by AI systems. AI systems collect and analyse data from production processes to identify patterns, inefficiencies, or potential issues. Skilled in analysing data allows the operator to make informed decisions and contribute to continuous improvement in the production line.

3. **Automation and Robotics:**
   Familiarity with automation and robotic technologies provides the ability to assist in field service tasks, such as automated inspection systems or drones for remote monitoring.

DIGITAL SKILLS

1. **IoT and Remote Sensing:**
   Knowledge of IoT devices and remote sensing technologies provides the knowledge to monitor real-time equipment performance and environmental conditions.

2. **Digital Training:**
   This skill provides the ability to use digital training resources and virtual reality (VR) simulations to stay updated on the latest equipment technologies and service techniques.

GREEN SKILLS

1. **Environmental Compliance:**
   Possessing such skills ensure that field operations comply with environmental regulations and industry standards for sustainability.

2. **Sustainable Practices:**
   Promoting sustainable practices within field service entails optimising travel routes to minimise fuel consumption and deliberately selecting eco-friendly materials for repair purposes.

3. **Life Cycle Assessment (LCA):**
   Understanding LCA provides the know-how to evaluate the environmental impact of field service activities and identify areas for improvement.

Engineering Operator

Process Operator

Technician (Production / Engineering / QC Technician)

Possible Roles for Transition into Other Sectors

Assembly, Test and Packaging Operator
Sector:
Electrical and Electronics

Engineering and Maintenance Technician
Sector:
Pharmaceutical Manufacturing

Highly Impacted Roles Career Pathways

(Continue)

Roles

QUALITY ASSURANCE AND QUALITY CONTROL (QA&QC) QUALITY ASSURANCE TECHNICIAN

Key Responsibilities:
Responsible for conducting inspections and tests to ensure that medical devices meet quality standards and regulatory requirements. This role involves performing routine quality checks, documenting findings, and assisting in the investigation of non-conformances. The Technician collaborates with production teams to provide feedback on quality issues, supports the implementation of corrective actions, and helps maintain quality documentation and records. This position contributes to continuous improvement efforts by identifying opportunities to enhance product quality and operational efficiency.

Examples of Additional Skills Required and Analysis

AI SKILLS

1. **AI-Based Defect Detection:**
   Proficiency in using AI-driven inspection systems for defect detection. AI systems with computer vision and machine learning algorithms can automatically detect product defects and anomalies during quality checks. Understanding how to operate, calibrate, and interpret results from these AI-based inspection systems enhances the ability to ensure product quality with greater precision and efficiency.

2. **Predictive Quality Analytics:**
   Ability to utilise AI for predictive analytics to forecast potential quality issues.

DIGITAL SKILLS

1. **Proficiency with Digital Quality Management Systems (QMS):**
   Expertise in using digital QMS software for tracking, managing, and documenting quality assurance processes.

2. **Data Analysis and Interpretation:**
   Ability to analyse and interpret data using digital tools such as spreadsheets, statistical software, or specialised quality analysis software.

GREEN SKILLS

1. **Sustainable Materials Evaluation:**
   Ability to assess and verify the sustainability of product materials.

2. **Waste Reduction and Management:**
   Expertise in implementing and managing waste reduction strategies within the quality assurance process.

Possible Roles for Transition within the Sector

Production Technician

Possible Roles for Transition into Other Sectors

Quality Control Assistant Laboratory Analyst
Sector:
Pharmaceutical Manufacturing

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

Projected Workforce Impact on Highly Impacted Employees

According to the TalentCorp Demand Model Projection, approximately 21% (13,000) of employees will be at risk in the next three (3) to five (5) years due to highly impacted roles.[40]

Summary of Highly Impacted Roles

Research and Development	Engineering and Maintenance	Production	Quality Assurance and Quality Control (QA & QC)
• Biostatistician • Lab Technician	• Engineering and Maintenance Supervisor	• Production Executive • Assembler (Production Operator)	• Quality Assurance Technician

Findings

Based on the TalentCorp Demand Model Projection, the workforce in the Medical Devices' core business is expected to be approximately 62,000 by 2029. According to assessments by industry experts, around 21% of these employees, approximately 13,000, may face job risks within the next three (3) to five (5) years as a result of roles being significantly affected.[41]

With AI playing an increasingly critical role in the Medical Devices sector, particularly in areas such as drug discovery and manufacturing, there is a growing demand for professionals in vital roles such as Biostatistician, Lab Technician, Engineering and Maintenance Supervisor, Production Executive, Assembler (Production Operator), and Quality Assurance Technician to possess skills in data analysis, machine learning, and AI algorithm development. The workforce must leverage AI tools to analyse large datasets, predict outcomes, and optimise processes effectively.

As digitalisation advances within the sector, the need for digital literacy across all workforce levels becomes increasingly essential. The workforce must be proficient in using digital tools, and cybersecurity skills will be key to protect sensitive data from potential breaches.

Developing and implementing green technologies, including renewable energy sources and biodegradable materials, will require innovation and technical expertise. Enhancing R&D capabilities to create sustainable alternatives to traditional manufacturing processes will ensure the sector progresses towards more environmentally friendly practices.

Over the next three (3) to five (5) years, AI and digital technologies will significantly impact these roles. As AI becomes more integrated into daily operations, professionals will need to adapt to the automation of routine tasks, advancements in data analysis, and optimisation of production processes. Developing AI, machine learning, and digital systems management skills will be essential for staying competitive and contributing effectively to the sector's growth. Embracing digital transformation will drive efficiency, improve product quality, and advance sustainable practices within the Medical Devices sector.

43. Impact Study Industry Survey
44. TalentCorp's Demand Model Projection; Department of Statistics Malaysia (DOSM);

Medium and Low Impacted Roles

Medium Impacted Roles Analysis

Medium impacted roles mainly centre around using technology to improve content production and delivery. Skills to better understand customer preferences are essential as the business moves towards a customer-centric model.

Industry stakeholders employ AI to optimise manufacturing processes, facilitate predictive maintenance, and enhance quality control. This results in heightened operational efficiency, decreased downtime, and elevated product quality. In addition, embracing digital transformation entails integrating the IoT, cloud computing, and advanced data analytics into operations, enabling real-time monitoring, informed decision-making, and improved operational efficiency.

Furthermore, it is imperative to actively adhere to local and international environmental regulations and pursue certifications such as ISO 14001 for environmental management. This commitment enhances sustainability, bolsters market competitiveness, and elevates corporate reputation.

Job Clusters	Medium Impacted Roles	Skills
Research and Development	Research and Development Engineer	**Specific Skills** • Big Data Analysis • Laboratory Data Analysis • Environment, Health and Safety **Basic Skills** • Business Acumen • Change Management • Sustainability Awareness
	Electrical Engineer	**Specific Skills** • Manufacturing Process Design • Semantic Design Skills • Data Management **Basic Skills** • Digital and AI Fluency • Innovative Thinking • Adaptability & Resiliency
	Mechanical Engineer	**Specific Skills** • Automated Operation Monitoring • Materials Management • Functional model **Basic Skills** • Adaptability & Resiliency • Teamwork & Collaboration • Change Management

Job Clusters	Medium Impacted Roles	Skills
Research and Development	Software Engineer	**Specific Skills** • Software Programing • Environment, Health and Safety • Technical Report Writing **Basic Skills** • Innovative Thinking • Sustainability Awareness • Adaptability & Resiliency
	Medical Device Specialist	**Specific Skills** • Technical Documentation • Testing and validation • Good Manufacturing Practices Implementation **Basic Skills** • Critical Thinking • Innovative Thinking • Sustainability Awareness
	Clinical Trial Manager	**Specific Skills** • Clinical Operations • Data Management • Clinical Report Writing **Basic Skills** • Innovative Thinking • Sustainability Awareness • Adaptability & Resiliency
	Clinical Data Manager	**Specific Skills** • Analytical method validation • Programming and Query Languages • Regulatory Compliance **Basic Skills** • Sustainability Awareness • Digital and AI Fluency • Critical Thinking
	Data Scientist	**Specific Skills** • Big Data Analysis • Process Validation • Innovation Management **Basic Skills** • Innovative Thinking • Digital and AI Fluency • Learning Agility

Job Clusters	Medium Impacted Roles	Skills
Research and Development	Patent Engineer / Intellectual Property Specialist	**Specific Skills** • Patent Inventions • Risk Management • Legal Knowledge **Basic Skills** • Adaptability & Resiliency • Business Acumen • Communication
Engineering and Maintenance	Engineering and Maintenance Director	**Specific Skills** • Continuous Improvement • Business Performance Management • Business Networking **Basic Skills** • Coaching and Mentoring • Conflict Management • Empathy
	Engineering and Maintenance Manager	**Specific Skills** • Equipment and Systems Testing • Preventive Maintenance • Business Continuity Management **Basic Skills** • Sustainability Awareness • Adaptability & Resiliency • Communication
	Engineering and Maintenance Technician	**Specific Skills** • Engineering & Maintenance • Cleaning and Sterilising • Installation and Assembly **Basic Skills** • Communication • Teamwork & Collaboration • Sustainability Awareness

Job Clusters	Medium Impacted Roles	Skills
Engineering and Maintenance	Manufacturing Engineer	**Specific Skills** • Computer Systems Validation • Equipment and Systems Repair • Facility Maintenance **Basic Skills** • Critical Thinking • Innovative Thinking • Digital and AI Fluency
	System Integration Engineer	**Specific Skills** • Systems Thinking • Project Management • Software Programing **Basic Skills** • Learning Agility • Innovative Thinking • Critical Thinking
Process Development / Manufacturing Science and Technology (MS&T)	Process Development / MS&T Manager	**Specific Skills** • Good Manufacturing Practices Implementation • Green Manufacturing Design and Implementation • Manufacturing Process Design **Basic Skills** • Coaching and Mentoring • Change Management • Conflict Management
	Process Development / MS&T Engineer	**Specific Skills** • Technical Report Writing • Environment, Health and Safety • Process Optimisation **Basic Skills** • Teamwork & Collaboration • Communication • Cognitive Skills

Job Clusters	Medium Impacted Roles	Skills
Production	Production Director	**Specific Skills** • Global Perspective • Risk Management • Business Networking **Basic Skills** • Critical Thinking • Coaching and Mentoring • Change Management
	Production Manager	**Specific Skills** • Environment, Health and Safety • Chemical Risk Management • Production Planning **Basic Skills** • Coaching and Mentoring • Empathy • Digital and AI Fluency
	Production Team Supervisor	**Specific Skills** • Cleaning and Sterilising • Bioreactor Operation and Control • Automated Process Control **Basic Skills** • Communication • Cognitive Skills • Sustainability Awareness
	Production Engineer	**Specific Skills** • Chromatography Equipment Operation and Control • Environment, Health and Safety • Manufacturing Systems Operation and Control **Basic Skills** • Sustainability Awareness • Adaptability & Resiliency • Critical Thinking

Job Clusters	Medium Impacted Roles	Skills
Production	Validation Engineer	**Specific Skills** • Risk Management • Technical Report Writing • Computer Systems Validation **Basic Skills** • Adaptability & Resiliency • Communication • Teamwork & Collaboration
	Calibration Engineer	**Specific Skills** • Analytical method validation • Continuous Improvement • Technical Report Writing **Basic Skills** • Adaptability & Resiliency • Teamwork & Collaboration • Cognitive Skills
	Production Planner	**Specific Skills** • Project Management • Risk Management • Computer Systems Validation **Basic Skills** • Innovative Thinking • Adaptability & Resiliency • Communication
	Demand Planner	**Specific Skills** • Regulatory Compliance • Risk Management • Good Manufacturing Practices Implementation **Basic Skills** • Innovative Thinking • Adaptability & Resiliency • Communication
Production	Material Planner	**Specific Skills** • Materials Management • Raw Materials and Utilities Testing • Project Management **Basic Skills** • Sustainability Awareness • Business Acumen • Adaptability & Resiliency
Quality Assurance and Quality Control (QA & QC)	Quality Assurance Executive	**Specific Skills** • Analytical method validation • Document Control • Audit Management **Basic Skills** • Communication • Teamwork & Collaboration • Sustainability Awareness
	Quality Control Engineer	**Specific Skills** • Quality Control Management • Technical Report Writing • Document Control **Basic Skills** • Adaptability & Resiliency • Communication • Teamwork & Collaboration
	Quality Control Inspector	**Specific Skills** • Raw Materials and Utilities Testing • Environment, Health and Safety • Technical Report Writing **Basic Skills** • Sustainability Awareness • Teamwork & Collaboration • Communication

Job Clusters	Medium Impacted Roles	Skills
Sustainability	Sustainability Manager	**Specific Skills** • Environment, Health and Safety • Sustainable Business Strategies • Eco-Design Principles **Basic Skills** • Sustainability Awareness • Business Acumen • Adaptability & Resiliency
	Sustainability Specialist	**Specific Skills** • Environmental Remediation • Sustainable Manufacturing • Strategic Planning and Development **Basic Skills** • Sustainability Awareness • Adaptability & Resiliency • Change Management
Site Management	Site Maintenance Engineer	**Specific Skills** • Maintenance Procedure Equipment • Preventive Maintenance • Sustainable Manufacturing **Basic Skills** • Critical Thinking • Adaptability & Resiliency • Conflict Management
Distribution, Marketing and Business Development Sustainability	Warehouse Manager	**Specific Skills** • Inventory Control • Warehouse Operations • Workplace Safety and Health **Basic Skills** • Digital and AI Fluency • Adaptability & Resiliency • Coaching and Mentoring

Job Clusters	Medium Impacted Roles	Skills
Distribution, Marketing and Business Development Sustainability	Warehouse Associate / Assistant / Material Handler	**Specific Skills** • Risk Management • Technical Report Writing • Computer Systems Validation **Basic Skills** • Adaptability & Resiliency • Communication • Teamwork & Collaboration
	Warehouse Inventory Manager	**Specific Skills** • Analytical method validation • Continuous Improvement • Technical Report Writing **Basic Skills** • Adaptability & Resiliency • Teamwork & Collaboration • Cognitive Skills
	Business Development Manager / Account Programme Manager	**Specific Skills** • Project Management • Risk Management • Computer Systems Validation **Basic Skills** • Innovative Thinking • Adaptability & Resiliency • Communication
	Procurement Executive	**Specific Skills** • Regulatory Compliance • Risk Management • Good Manufacturing Practices Implementation **Basic Skills** • Innovative Thinking • Adaptability & Resiliency • Communication

A Brief Illustration of Medium Impacted Roles

Engineers: AI can automate routine tasks like data analysis and simulations, but human expertise is still highly essential for interpreting results, designing experiments, and applying insights creatively. Skills in data science, machine learning, and innovation management are vital.

Medtronic utilises advanced AI and machine learning algorithms in R&D to accelerate the design and development of medical devices. For example, their digital platforms assist in analysing patient data to inform product development and optimise device performance. Medtronic employs AI to develop new cardiac devices and innovations in diabetes management, with AI algorithms helping to design devices that more precisely address patient needs.[42]

Electrical Engineers: AI can automate circuit design and predict maintenance needs, yet engineers still play a key role in complex design, system integration, and cybersecurity. Essential skills include embedded systems knowledge, advanced circuit design, and cybersecurity expertise.

Boston Scientific uses automation and AI to streamline its medical devices' design and production processes. This includes automating circuit design and testing processes to improve efficiency and accuracy. Automation is used in designing implantable devices, like pacemakers and stents, where AI tools help optimise electronic circuit designs.[43]

Low Impacted Roles

Low impacted roles require high levels of creativity, judgement, and interaction and are least affected by evolving trends. However, skills to leverage technology and drive the sustainability agenda will become increasingly important in the future.

It is encouraged for industry players to participate in industry-specific sustainability initiatives and forums to share best practices, collaborate on sustainability research, and collectively advocate for regulatory policies that support green manufacturing. They should embrace transparent reporting mechanisms to communicate environmental performance metrics, sustainability goals, and progress to stakeholders, fostering trust and accountability.

Furthermore, industry players must embrace the adoption of IoT and smart manufacturing. For example, they must deploy IoT devices for real-time monitoring of equipment and environmental conditions, enabling proactive maintenance and resource efficiency.

Job Clusters	Low Impacted Roles	Skills
Research and Development	Researcher (Material Scientist)	**Specific Skills** • Big Data Analysis • Sustainable Business Strategies • Innovation Management **Basic Skills** • Digital and AI Fluency • Critical Thinking • Sustainability Awareness
Production	Clinical Research Scientist	**Specific Skills** • Clinical Study Design • Medical Report Writing • Big Data Analysis **Basic Skills** • Critical Thinking • Digital and AI Fluency • Sustainability Awareness
Process Development / Manufacturing Science and Technology (MS&T)	Process Development / MS&T Director	**Specific Skills** • Risk Management • Global Perspective • Business Networking **Basic Skills** • Coaching and Mentoring • Conflict Management • Business Acumen
Production	Molding Engineer	**Specific Skills** • Non-Biological Product Introduction • Clinical Study Design • Innovation Management **Basic Skills** • Critical Thinking • Learning Agility • Change Management
Quality Assurance and Quality Control (QA & QC)	Quality Assurance & Quality Control Manager	**Specific Skills** • Quality Assurance Management • ISO standard competencies • Quality Control Management **Basic Skills** • Critical Thinking • Sustainability Awareness • Coaching and Mentoring

45. Medtronik, AI is unlocking the future of health tech, <https://www.medtronic.com/us-en/our-company/ai-healthcare-technology.html>
46. Warren Wang, How is AI Transforming Healthcare?, Boston Scientific, 14 March 2019, <https://news.bostonscientific.com/warren-wang-how-is-ai-transforming-healthcare>

Job Clusters	Low Impacted Roles	Skills
Regulatory, Compliance and Security	Regulatory and Compliance Officer	**Specific Skills** • Regulatory Compliance • Audit Management • ISO standard competencies **Basic Skills** • Learning Agility • Sustainability Awareness • Teamwork & Collaboration
Site Management	Site Director /Head	**Specific Skills** • Budget Preparation • Risk Management • Strategic Planning and Development **Basic Skills** • Coaching and Mentoring • Change Management • Business Acumen
Sustainability	Environment , Health and Safety Manager	**Specific Skills** • Environment, Health and Safety • Sustainable Manufacturing • Waste Management **Basic Skills** • Innovative Thinking • Change Management • Coaching and Mentoring

A Brief Illustration of Low Impacted Roles

Clinical Research Scientists in the Medical Devices sector are encouraged to adapt to advancements in automation and digital technologies. Companies like Medtronic, Abbott Laboratories, and Philips Healthcare are taking the lead in integrating these technologies into clinical research. To stay relevant, Clinical Research Scientists need to upgrade their skills in advanced data analytics, AI and machine learning, EDC systems, regulatory compliance, CTMS, and data privacy. These skills are crucial for effectively leveraging automation and digital tools to manage and optimise clinical trials.

Regulatory and Compliance Officers in the Medical Devices sector can increasingly benefit from automation and digital technologies. Companies like Medtronic, Johnson & Johnson, and Philips Healthcare utilise these technologies to streamline compliance processes and regulatory management. To stay competitive, officers should enhance their skills in using Regulatory Information Management Systems (RIMS), data analytics, digital compliance tools, cybersecurity, change management, regulatory knowledge, and project management. These skills are essential for effectively navigating the evolving landscape of regulatory compliance in a digital environment.

Projected Numbers of Medium and Low Impacted Employees

Approximately 79% (49,000) of medium and low impacted employees require upskilling that's related to AI, Digital, and Green Economy:[44]

- Based on assessments and industry feedback, 125 essential skills (both basic and specific) have been identified for the Medical Devices sector, with 10% of these being AI/Digital skills and 9% Green Economy skills.
- Upskilling is essential for 44% of roles classified as medium impacted roles to exceed traditional performance expectations.
- Although upskilling is not mandatory for the 35% of roles classified as low impacted roles, continuous self-improvement is recommended to stay relevant and make informed decisions, especially to stay current with emerging trends.

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

AI/ Digital Skills

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

- Automated Equipment and Control Systems Configuration
- Predictive Maintenance
- Preventive Maintenance
- Analytical Method Validation
- Big Data Analytics
- Machine Learning Models

Green Skills

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

- Environmental Awareness
- Health, Safety, and Environment Procedures Implementation
- Sustainable Business Practices
- Eco-Design Principles
- Renewable Energy
- Sustainable Manufacturing
- Waste Management
- Green Manufacturing Design and Implementation

Training Programmes Available

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

47. Department of Statistics Malaysia (DOSM) and TalentCorp Demand Model Projection

Emerging Roles

Global Presence of Emerging Roles in the Medical Devices Sector

The landscape of the global Medical Devices manufacturing sector is also witnessing the rise of new and influential roles. Emerging roles, such as AI Diagnostics Engineer, Telehealth and Remote Monitoring Specialist, and AI Digital Marketing and Cloud Computing Engineer, are becoming increasingly prominent in the Medical Devices sector globally. This trend is particularly evident in countries like the United States (US), the United Kingdom (UK), Germany, China, and India.

AI Diagnostics

AI Diagnostic engineers focus on integrating AI into medical devices to improve diagnostic accuracy, efficiency, and patient outcomes. **Boston Scientific** develops AI solutions for minimally invasive medical devices. The AI diagnostic engineers focus on algorithm development and integration with medical device systems. **Abbott Laboratories** applies AI to diagnostic testing and imaging devices, with engineers focusing on developing AI algorithms, ensuring regulatory compliance, and validating clinical performance. The landscape of AI in diagnostic engineering is also marked by notable advancements in other leading countries. The US, a pioneer in medical device innovation, is at the forefront of integrating AI into products, with many companies pushing the boundaries of technology and navigating complex regulatory environments. Meanwhile, in Germany and the UK, engineers are also integrating AI into medical devices, but with a focus on adhering to European regulations.

Telehealth and Remote Monitoring Specialist

Telehealth specialists are essential for ensuring that medical devices are compatible with telehealth systems and for contributing to the development of innovative solutions for remote patient monitoring and care. While this is an emerging job role in Malaysia, countries like the US and Canada have highly developed healthcare systems with a strong focus on integrating telehealth and medical devices. **Siemens** works on innovative medical technology and telehealth solutions, integrating their devices into remote monitoring and telehealth systems. **Abbott Laboratories** develops medical devices and health monitoring technologies, including those used in telehealth and remote patient monitoring.

AI Digital Marketer

AI digital marketers are increasingly being utilised in the Medical Devices sector to enhance marketing strategies, improve customer engagement, and drive sales across various countries. In the US, which is a leading adopter of AI in digital marketing, companies use AI for personalised marketing, predictive analytics, and customer segmentation. Notable examples include **Medtronic** and **Abbott**, which leverage AI-driven tools to optimise their marketing strategies. Similarly, in the UK, AI is enhancing digital marketing efforts within the Medical Devices sector. Companies like **Smith & Nephew** are adopting AI technologies for targeted advertising, content optimisation, and gaining customer insights. This widespread adoption underscores the growing impact of AI in refining marketing practices across the sector.

Demand Projection for Emerging Roles

Companies are increasingly recognising the benefits of emerging technology and sustainability practices in a dynamic market environment; therefore, the demand for such emerging specialists is expected to grow. Based on input collected from industry players during the impact assessment workshop, the headcount of organisations varies according to company type. MNCs reported headcounts ranging from 180 to 11,000 employees. No data is available for SMEs, and there is no representation from Government-linked Companies (GLCs) and PLCs.

As Malaysia's Medical Devices sector evolves with the increasing influence of AI, Digital, and Green Economy, four (4) emerging roles have been identified as key drivers of this transformation, namely, AI Diagnostics Engineer, Data Scientist, AI Digital Marketing, and Cloud Computing Engineer.

Chapter 5:
Recommended Initiatives

The impact study assessment has yielded valuable insights into the evolving landscape shaped by AI, Digital, and Green Economy trends within Malaysia's Medical Devices sector. Eight (8) initiatives were developed through extensive collaboration with key stakeholders, including Government, Industry Players, Academia, and Training Providers. The recommended initiatives aim to harness the opportunities identified and address the challenges posed by these transformative trends. By aligning with the needs and aspirations of each stakeholder group, we seek to foster innovation, promote skill development, and ensure the sustainable growth of the Medical Devices sector.

Summary of eight (8) Recommended Initiatives

Government

IN1
Provide Funding and Incentives

IN2
Implement Regulation, Policy and Initiatives

Industry Players

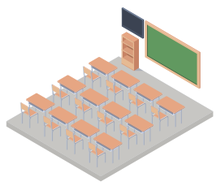
IN3
Implement Talent Development Programmes

IN4
Initiate and Drive Research and Innovation

Academia

IN5
Design and Update Curriculum Development Plans

IN6
Establish and Enhance Internship and Work Readiness Programmes



Training Providers

IN7
Create and Deliver Content Development Strategies and Programmes

IN8
Offer Develop and Manage Certification and Credential Programmes

Government

IN1 Provide Funding and Incentives

This initiative focuses on the financial support and incentives provided by governments, organisations, or institutions to assist in specific activities. These may include grants, loans, tax credits, or other monetary benefits designed to encourage investment, innovation, research, and development, as well as other strategic initiatives that align with policy goals or business objectives, particularly in workforce development.

Initiatives	Case Studies
IN1.1 **Allocate significant financial incentives and resources for R&D in AI, digital technologies, and sustainable practices.** This includes providing substantial grants and funding opportunities to support innovative projects, thereby reducing financial barriers for research institutions and businesses. Tax breaks and credits will also encourage further investment in these areas.	The European Union (EU) launched '**Horizon Europe**' in 2021, focusing on providing funds for AI-related projects, digital health technologies, and green innovations.[45] In the US, a project called **Advanced Research Projects Agency for Health (ARPA-H)** was launched in 2022 to fund cutting-edge research in digital health and AI.[46]
IN1.2 **Invest in upskilling programmes to enhance workforce capabilities in emerging sectors.** This initiative will include developing specialised training programmes in collaboration with educational institutions, ensuring accessibility through online and hands-on courses, as well as creating industry-relevant curricula.	'**Japan Digital Skills Training**' Programme was launched in 2021 to provide training in digital skills, including AI applications in medical technologies.[47] Australia introduced 'Clean Energy Training Programmes' in 2021 to support training programmes related to clean energy and green technologies, including applications in the Medical Devices sector.[48]
IN1.3 **Provide a range of upskilling training programmes** that cater to various roles within the sector by offering accredited certification courses specifically designed for the Medical Devices sector, focusing on foundational and advanced concepts.	In Canada, the **Canadian Medical Device Industry (CMDI)** has participated in consultations on Health Canada's framework for integrating AI into medical devices and green technology.[49] Also, the German Medical Technology Association (BVMed) provided input on EU's Digital Health Strategy and supported initiatives for sustainable practices.[50]

48. European Commision, *Horizon 2020*, <https://research-and-innovation.ec.europa.eu/funding/funding-opportunities/funding-programmes-and-open-calls/horizon-2020_en>
49. ARPA, *ARPA-H launches programme to help AI-enabled medical tools maintain peak performance*, <https://arpa-h.gov>
50. Nikkei Asia, *Japan government to shift vocational training focus to digital skills*, 6 June 2022, <https://asia.nikkei.com/Economy/Japan-government-to-shift-vocational-training-focus-to-digital-skills>
51. Transgrid, *How upskilling Australians could be the gamechanger in accelerating our clean energy transition*, <https://www.transgrid.com.au/energy-transition/how-upskilling-australians-could-be-the-gamechanger-in-accelerating-our-clean-energy-transition>
52. Canadian Medical Device Industry, <https://www.cmdi.ca/>
53. BVMed, Bundesverband Medizintechnologie, <https://www.bvmed.de/>

Benefits

Stimulates Innovation and Development:
Government incentives can drive technological advancements and innovation by providing financial support for R&D. This funding helps companies invest in new technologies, develop cutting-edge products, and stay competitive.

Facilitates Compliance with Regulatory Standards:
Incentive programmes can help companies meet complex regulatory requirements by offsetting the costs associated with compliance. This support ensures that businesses adhere to industry standards and regulations, which are essential for maintaining market access and avoiding penalties.

Promotes Sustainability and Environmental Responsibility:
Government incentives often target sustainability initiatives, encouraging companies to adopt eco-friendly practices and technologies. This support not only helps businesses reduce their environmental footprint but also aligns them with broader societal and regulatory goals related to sustainability.

IN2 Implement Regulation, Policy and Initiatives

This initiative focuses on creating regulations and programmes to ensure a skilled and compliant labour force. These policies aim to enhance industry standards, support innovation, and promote the safe and effective development and distribution of medical devices, while also addressing workforce needs such as education, training, and ethical practices.

Initiatives	Case Studies
IN2.1 **Reform the educational curriculum to encourage creativity and align with global best practices,** preparing students for future critical thinking and problem-solving challenges.	**Singapore** continuously updates its curriculum to include future-ready skills like computational thinking and problem-solving, with a strong emphasis on digital literacy and green technology. The latest updates incorporate the '21st Century Competencies' framework, which focuses on critical thinking, creativity, and cross-disciplinary skills.[51] **Finland** is renowned for its progressive education system. The latest curriculum updates emphasise project-based learning, interdisciplinary approaches, and skills relevant to digital and green economies.[52]
IN2.2 **Review TVET programmes** as a place for impacted roles for upskilling.	In 2023, South Korea updated its TVET programmes to include training in AI, digital skills, and green technologies. The government also launched new initiatives to align vocational training with the future needs of industry.[53] Similarly, in 2023, China expanded its TVET system to incorporate AI and green technology skills. New programmes and curricula emphasise digital skills and environmental sustainability, aligning with the country's national development goals.[54]

54. Ministry of Education Singapore, *21st Century Competencies*, <https://www.moe.gov.sg/education-in-sg/21st-century-competencies>
55. Finnish National Agency for Education, *National core curriculum for primary and lower secondary (basic) education*, <https://www.oph.fi/en/education-and-qualifications/national-core-curriculum-primary-and-lower-secondary-basic-education>
56. Korean Ministry of Employment and Labour, <https://www.kmooc.kr>
57. Ministry of Education of the People's Republic of China, *China's TVET Programmes*, <http://www.moe.gov.cn/>

Initiatives	Case Studies
IN2.3 **Introducing sustainability standards set by regulations or industry guidelines.** This includes adopting practices and technologies that reduce environmental impact and enhance sustainability within business operations.	In 2021, the EU introduced '**European Green Deal**' and the '**EU Taxonomy for Sustainable Activities**,' which are comprehensive frameworks that include sustainability standards for various sectors, including digital and AI technologies.[55] In 2022, the **US Securities and Exchange Commission (SEC)** introduced new rules for climate-related disclosures, which require companies to report their environmental impacts, including those related to digital technologies and AI.[56]

Benefits

Sustainability Compliance:
Adhering to sustainability standards enhances a company's reputation and market presence. As environmental concerns become increasingly important to consumers and stakeholders, a commitment to sustainability can differentiate a company from its competitors.

Reforming the Education System:
Reforming the education system to focus on relevant skills and practical knowledge better prepares students for the workforce. This alignment ensures graduates have the skills needed for current and future job markets.

TVET (Technical and Vocational Education and Training) Programme:
TVET programmes provide practical, hands-on training that aligns with industry needs. This focused approach ensures that students gain relevant skills directly applicable to their chosen professions.

Industry Players

IN3 Implement Talent Development Programmes

This initiative narrows down on programmes and initiatives to enhance the abilities and competencies of the workforce, preparing them for both current and future job roles. It emphasises providing the necessary education, vocational training, and professional development opportunities to meet the evolving demands of the labour market and drive economic growth.

Initiatives	Case Studies
IN3.1 **Implement a robust personal development plan** that provides a pathway for career advancement and skill acquisition to equip employees for future roles—benchmarking between industry players to know the market trend.	**Boston Scientific Learning and Development** provides extensive learning resources focused on emerging technologies like AI and digital innovations in the Medical Devices sector. The company also promotes sustainability through its training programmes.[57] **Smith & Nephew Learning Academy** offers professional development opportunities for digital health technologies and sustainable practices. The programme includes certifications and hands-on training.[58]

58. European Commission, *Sustainable Finance*, <https://finance.ec.europa.eu/sustainable-finance_en>
59. U.S. Securities and Exchange Commission, *SEC Adopts Rules to Enhance and Standardise Climate-Related Disclosures for Investors*, <https://www.sec.gov/newsroom/press-releases/2024-31>
60. Boston Scientific, *Students and early careers*, <https://www.bostonscientific.com/en-US/careers/students.html>
61. Smith+Nephew, *Your destination for unlimited education with Smith+Nephew Academy Online*, <https://educationunlimited.smith-nephew.com>

Initiatives	Case Studies
IN3.2 **Adopt a proactive approach to retain high-skilled talent** and commit to the continuous upskilling of current employees to meet evolving industry needs using an online platform.	**Boston Scientific Learning and Development** offers an extensive online learning platform with courses and certifications on the latest medical technologies, including digital innovations and advanced device development. It focuses on skill enhancement and career progression.[59] **Johnson & Johnson MedTech Learning** Hub provides online training resources and modules on various aspects of medical technology, including emerging digital solutions and new regulatory standards. It is designed to support continuous learning and career development for employees.[60]
IN3.3 **Offer students on-site learning experiences and implement a micro-credential system** to certify their ability to perform sustainable and diverse roles.	**BD (Becton, Dickinson, and Company)** provides on-site summer internships for students, focusing on practical learning in medical device technology and sustainability. The programme includes a micro-credential system to recognise the students' abilities in diverse and sustainable roles.[61] **Abbott Laboratories Internship Programme** offers on-site internships that allow students to learn hands-on in various aspects of the Medical Devices sector. The programme features micro-credentialing for skills related to sustainability and diverse technical roles.[62]

Benefits

Workforce Development and Career Growth:
Implementing a robust personal development plan that provides a clear pathway for career advancement and skill acquisition ensures that employees are well-prepared for future roles. This can lead to increased job satisfaction, higher productivity, and better retention rates as employees see opportunities for growth within the organisation.

Talent Retention and Organisational Competitiveness:
Adopting a proactive approach to retaining high-skilled talent and continuously upskilling current employees helps organisations remain competitive in an evolving industry landscape. By fostering a culture of learning and innovation, companies can maintain a strong talent pool ready to address emerging industry needs, ultimately contributing to both organisational success and the sector's overall competitiveness.

Educational Relevance and Workforce Readiness:
Offering students on-site learning experiences and implementing a system of micro-credentials to certify their abilities can bridge the gap between education and employment. These practical experiences and certifications ensure that students are job-ready and have verifiable skills relevant to sustainable and diverse roles.

Human-Centric Technology Integration:
A strategic balance between AI/automation and human talent ensures that technology enhances jobs rather than replaces them. This approach can lead to more innovative and efficient work processes where technology supports human workers, allowing them to focus on higher-value tasks that require creativity, empathy, and strategic thinking.

62. Boston Scientific, *Students and early careers*, <https://www.bostonscientific.com/en-US/careers/students.html>
63. Johnson&Johnson *MedTech, Personalised Learning on JnJInstitute.com*, <https://www.jnjmedtech.com/en-US/support/jnj-institute-hcp-education>
64. BD, *Early Talent*, <https://jobs.bd.com/early-talent>
65. Abbott, *Internships*, <https://www.abbott.com/careers/students/internships.html>

IN4 Initiate and Drive Research and Innovation

This initiative involves collaborating with others, often across different fields or disciplines, to conduct systematic research and gather information. The goal is to discover new insights, solve problems, or develop new products and processes. By leveraging diverse expertise and perspectives, this approach enhances the quality and effectiveness of research outcomes.

Initiatives	Case Studies
IN4.1 **Forming strategic partnerships with government entities** and academic institutions to establish cutting-edge R&D labs.	**Boston Scientific Learning and Development** offers an extensive online learning platform with courses and certifications on the latest medical technologies, including digital innovations and advanced device development. It focuses on skill enhancement and career progression.[63] **Johnson & Johnson MedTech Learning** Hub provides online training resources and modules on various aspects of medical technology, including emerging digital solutions and new regulatory standards. It is designed to support continuous learning and career development for employees.[64]

66. B Hochschule, *Jetzt Studienplatz sichern Digital Health M.Sc.*, <https://www.ib-hochschule.de/microsite/msc-digital-health/>
67. Ilias Ism, *Switzerland: Leading the Healthtech Revolution, Swiss Observer*, 26 October 2023, <https://swissobserver.com/swiss-healthtech/>

Initiatives	Case Studies
IN4.2 **Enhance CSR efforts through outstanding teamwork and collaboration** with the academic sector, thus advancing support for education and research initiatives.	**Johnson & Johnson Innovation**—JLABS, launched in 2012, is a global network of incubators that provides startup companies, including those in the Medical Devices sector, with access to resources such as research facilities and educational programmes. This initiative collaborates with academic institutions to foster innovation and support research and development in medical technology.[65] **Boston Scientific's** Research, Innovation, and Support for Education (RISE) Programme was launched in 2020 to support collaborations with universities and research institutions to advance medical research and education. It includes funding for research projects and educational initiatives, aiming to foster innovation and enhance healthcare outcomes.[66]

Benefits

Skill Enhancement and Professional Development:
This initiative addresses the growing need for expertise in these rapidly evolving fields. It can lead to a workforce that is better equipped with the latest knowledge and skills, which is essential for driving innovation and maintaining a competitive edge. Professionals who undergo such training can advance their careers and contribute more effectively to their organisations' success.

Innovation and Technological Breakthroughs:
Forging partnerships with government entities and academic institutions to establish R&D labs creates an ecosystem conducive to innovation and technological breakthroughs. These labs can serve as incubators for cutting-edge research, fostering teamwork and collaboration between scientists, engineers, and industry experts.

Industry Growth and Economic Development:
Encouraging more significant financial commitment from industry players to support research, development, and innovation can lead to substantial economic development. When businesses invest in R&D, they contribute to the creation of new technologies, stimulate job creation, and gain a first-mover advantage in the market.

Strengthened Corporate-Academic Ties:
Enhancing CSR efforts by increasing teamwork and collaboration with the academic sector to support education and research initiatives can strengthen the ties between corporations and educational institutions. This partnership can provide valuable resources for scholarly research and offer real-world insights and opportunities for students.

68. Johnson&Johnson, *Everything you need aimed to support you in creating the next great potential healthcare breakthrough*, <https://jnjinnovation.com/jlabs>
69. Boston Scientific's Research, Innovation, and Support for Education (RISE) Programme, <https://www.bostonscientific.com/en-US/investigator-sponsored-research.html>

Academia

IN5 Design and Update Curriculum Development Plans

Academia needs to actively seek partnership with sector experts to ensure that educational content is aligned with current sector standards. This collaboration enhances the relevance of the curriculum and syllabus, effectively preparing students with the knowledge and skills needed for the workforce. Consequently, bridging the gap between knowledge and real-world experience.

Initiatives	Case Studies
IN5.1 **Restructure the education system** by establishing a solid partnership with the industry to develop a curriculum that focuses on practical and technical projects relevant to industry needs, including integrating emerging roles and technologies such as AI, Digital, and ESG.	In the UK, the '**T Levels Qualifications**' project was introduced in 2020. T Levels are new technical qualifications designed in collaboration with industry experts to focus on practical and technical skills for emerging roles, including those related to digital technologies, AI, and sustainability. Developed with significant input from industry partners, these qualifications aim to ensure relevance to current job markets.[67] In the Netherlands, the project '**Innovation & Technology Sectoral Cooperation**' was launched in 2022. This project involves partnerships between Dutch universities, technical schools, and industry leaders to co-create curricula focusing on practical and technical skills in emerging technologies like AI and digitalisation. The initiative aims to align educational content with industry requirements and future job markets.[68]
IN5.2 **Introduce students to AI and digital-related subjects** from a young age and maintain a dynamic curriculum that can quickly adapt to technological advancements. This will ensure that students are familiar with and skilled in the latest tools and methods.	'**Computing Curriculum 2020**' was adopted in the UK to include a comprehensive computing curriculum emphasising coding, AI, and digital literacy from an early age. The curriculum is designed to be flexible and adapt to new technological developments, ensuring students are familiar with the latest digital tools and methods.[69] In China, the '**AI and Robotics Curriculum Integration**' programme was introduced in 2022. The project aims to provide students with early exposure to AI concepts and digital technologies, ensuring that educational content evolves with technological advancements, and prepares students for future careers in these fields.[70]

70. HM Government, T-Levels, <https://www.tlevels.gov.uk/>
71. Nederland Digitaal, *The Dutch Digitalisation Strategy 2021*, 2021
72. Gov.uk, *Research review series: computing*, 16 May 2022, <https://www.gov.uk/government/publications/research-review-series-computing/research-review-series-computing>
73. Li Zhen, *Artificial intelligence holds key to future education, People's Daily Online*, 11 April 2024, <http://en.people.cn/n3/2024/0411/c90000-20155752.html>

Benefits

Enhanced Employability and Job Readiness:
By restructuring the education system to focus on practical and technical projects, students will acquire relevant skills, leading to a smoother transition from education to employment. This approach better prepares students to meet workplace demands. With a curriculum that includes emerging roles and new technologies, students are equipped with the knowledge and skills increasingly sought after by employers.

Future-Proofing Education:
Introducing AI and digital-related subjects early and maintaining a dynamic curriculum that can quickly adapt to technological advancements ensures that the education system remains relevant. This helps to future-proof education by continuously integrating the latest tools and methods.

Economic Growth and Competitiveness:
A workforce well-versed in AI, digitalisation, and ESG can drive innovation and productivity, leading to economic growth. As industries evolve with technological advancements, having a talent pool that is already familiar with these changes can give businesses a competitive edge.

IN6 Establish and Enhance Internship and Work Readiness Programmes

This initiative involves developing partnerships between educational institutions, students, and businesses to provide practical, hands-on work experience. This synergy enables students to apply academic knowledge in real-world settings, gain valuable industry insights, and develop professional skills. Meanwhile, organisations benefit from fresh perspectives and the potential to recruit emerging talent.

Initiatives	Case Studies
IN6.1 **Academic institutions to co-develop internships** to expose students to actual industry settings. This would involve ensuring syllabus and course content are AI, Digital, and Green Economy driven, directly relevant to industry needs.	In Singapore, the **National University of Singapore (NUS)** partnered with **Philips** to provide students with internships and co-developed courses focusing on digital health technologies, AI applications in the Medical Devices sector, and green innovation. The collaboration aimed to bridge the gap between academic learning and industry requirements.[71] **Imperial College London and Johnson & Johnson** collaborated in 2021 to create industry-focused internships and academic courses. The curriculum includes training on AI technologies, digital health solutions, and sustainability practices that are relevant to the Medical Devices sector.[72]

Initiatives	Case Studies
IN6.2 **Academic institutions to collaborate with industry to cultivate graduates who can bridge the gap between academic research and practical industry applications,** facilitating the adoption of new technologies and addressing industry challenges.	In Germany, **the Technical University of Munich (TUM)** and **Siemens Healthineers** established a joint initiative known as the TUM-Siemens Healthineers Innovation Hub in 2023. This partnership involves collaborative research, industry-focused internships, and specialised courses integrating academic study with practical medical device applications. The initiative is designed to cultivate graduates who can facilitate the adoption of new technologies and solve industry-specific problems.[73] In Switzerland, ETH Zurich and Roche have partnered to develop the **ETH-Roche Innovation Centre** in 2023. This centre emphasises research in biomedical technologies and includes collaborative projects, industry internships, and educational programmes designed to connect academic study with practical industry applications. The goal is to equip graduates with the skills to facilitate the adoption of new technology and address industry challenges.[74]

Benefits

Improved Workforce Readiness and Practical Experience:
By co-developing internships with industry partners, academic institutions can provide students with hands-on experience in actual industry settings. This exposure allows students to apply their theoretical knowledge in real-world scenarios, understand workplace dynamics, and develop practical skills that are highly valued by employers.

Curriculum Relevance and Responsiveness to Industry Trends:
Ensuring that AI, Digital, and Green Economy drive syllabus and course content and are directly relevant to industry needs. This relevance ensures that students learn about current issues and solutions, making them more innovative and adaptable to changes in the job market.

Enhanced Teamwork, Collaboration, and Innovation:
Working with the industry to cultivate graduates who can bridge the gap between academic research and practical industry applications fosters a symbiotic relationship between academia and the private sector. This collaboration plants the seeds for adopting new technologies and addressing real-world industry challenges. These graduates can drive innovation, leading to technological advancements, processes, and products.

74. National University of Singapore (NUS), *Philips on Campus: The rise of health technology*, <https://nus.edu.sg/cfg/events/details/3589>
75. Imperial, Johnson & Johnson, <https://www.imperial.ac.uk/enterprise/business/industry-partnerships-and-commercialisation/industry-partnerships/featured-partnerships/johnson--johnson/>
76. Technical University of Munich, *Siemens opens its largest cooperation centre worldwide at TUM*, 17 April 2024, <https://www.tum.de/en/news-and-events/all-news/press-releases/details/siemens-opens-its-largest-cooperation-center-worldwide-at-tum>
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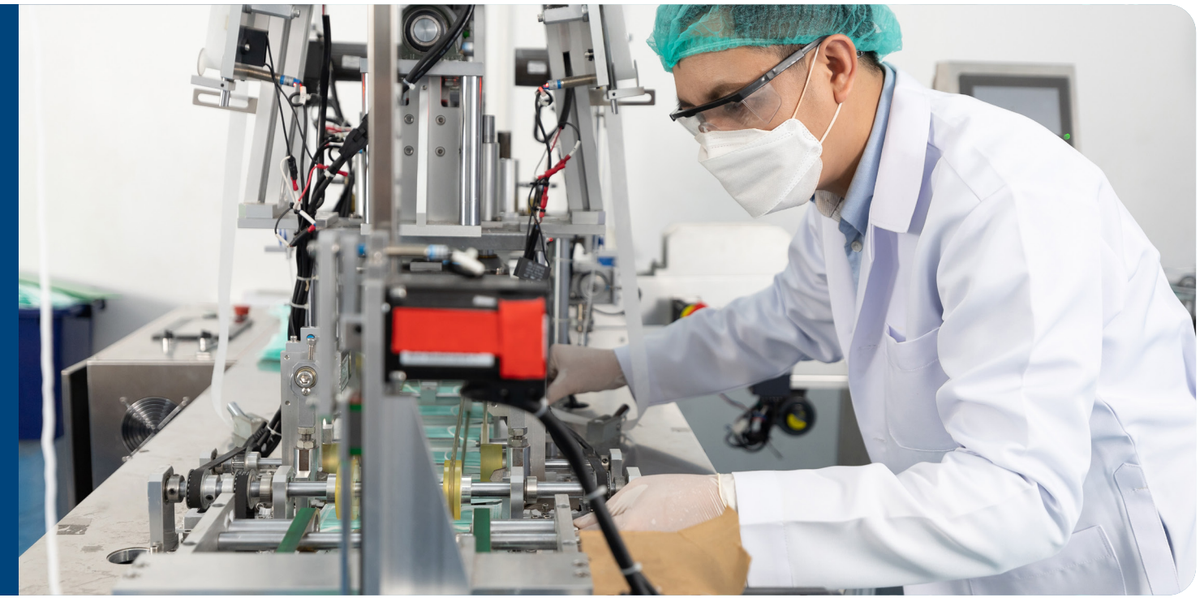

Training Providers

IN7 Create and Deliver Content Development Strategies and Programmes

This initiative employs a systematic approach to present educational content and facilitate learning experiences in a training programme. It encompasses the strategies, techniques, and tools used to effectively transfer knowledge and skills to learners.

Initiatives	Case Studies
IN7.1 **Transition from traditional one-way seminars to more integrated workshops** that encourage active participation, discussion, and hands-on activities. This approach will foster a deeper understanding of the material and promote the practical application of skills.	**Biomed Training Solutions** offers a comprehensive training programme that requires participants to complete real-world projects and internships. These components provide practical exposure to medical device technologies and industry practices, ensuring learners can apply their training in a real-world context and reinforce their skills.[75]
IN7.2 **Making practical attachments a compulsory component of training programmes.** This involves on-the-job training, internships, or real-world projects for participants to apply their knowledge, reinforce continuous learning, and improve skill retention.	

78. Biomed Laboratory Training, *Biomed Lab Training: Training your way to success*, <https://www.biomedlabtraining.com/>

Initiatives	Case Studies
IN7.3 **Invest in comprehensive train-the-trainer programmes** to ensure that trainers are well-equipped to teach new technologies and methodologies. Additionally, upskilling training is based on the needs assessment, considering both internal resources and external training providers.	**Zimmer Biomet** offers the '**Trainer Excellence Programme**', which focuses on developing trainers' skills to teach advanced medical devices technologies and methodologies effectively. The programme includes comprehensive training for trainers, including technology updates, instructional techniques, and practical applications. Zimmer Biomet also conducts needs assessments to tailor upskilling programmes, utilising internal expertise and external training resources.[76]
IN7.4 **Continuously work on skills enhancement and grants** to ensure training is aligned with the latest industry standards and technological advancements. Also, to ensure that there is continuous financial support to conduct the training.	

Benefits

Enhanced Workforce Competency and Productivity:
Executing a well-allocated budget for upskilling based on a needs assessment ensures that employees receive training that is directly relevant to their roles and the company's strategic goals. This relevance boosts their competency, leading to increased productivity and efficiency in their work. Tailoring training programmes to the current level of digital literacy can help employees progress from their existing knowledge base, reducing the learning curve and accelerating the adoption of new skills.

Improved Employee Engagement and Retention:
By investing in employees' professional development, organisations are committing to their workforce's growth and career progression. This investment can lead to higher employee engagement, as employees feel valued and see a clear path for advancement within the company.

Financial Sustainability and Strategic Advantage:
Exploring partnerships with organisations and seeking government grants and incentives for re-training can provide financial relief and sustainability for the organisation's upskilling initiatives. These partnerships and incentives can reduce the overall cost of training programmes, allowing the organisation to allocate resources more effectively and potentially train more employees than without such support.

Enhanced Learning Outcomes:
Transitioning to integrated workshops that prioritise active participation and hands-on activities improves learning outcomes. Participants are more likely to engage deeply with the material, understand complex concepts, and retain information when actively involved in learning. It also encourages critical thinking and problem-solving.

Improved Skill Application and Retention:
Ensures that participants can immediately apply what they have learned in a real-world context. On-the-job training, internships, and project-based learning bridge the gap between theory and practice, significantly enhancing skill retention.

79. Ibid

Benefits
Effective Knowledge Transfer and Change Management: Investing in train-the-trainer programmes prepares trainers to disseminate new technologies and methodologies within the organisation effectively. By equipping trainers with the latest knowledge and teaching strategies, they can better support employees through transitions and technological upgrades, which helps minimise resistance to change, accelerates the adoption of new processes, and ensures that the workforce is prepared to meet future challenges.

IN8 Develop and Manage Certification and Credentialing Programmes

This initiative involves the development of training programmes that align with the sector's needs, including the creation of new learning modules, the design of complex courses with certifications, and the transition from traditional seminars to more interactive and practical workshops.

Initiatives	Case Studies
IN8.1 **Invest and regularly monitor and tally the latest developments** in AI, Digital, and Green Economy with the evolving Medical Devices sector needs.	EU's '**Horizon Europe**' is the key funding programme for research and innovation that includes initiatives to monitor and invest in AI and digitalisation, focusing on sustainable development.[77] A similar approach was implemented by the Japanese government under Japan's '**Society 5.0**'. This initiative aimed to integrate advanced technologies like AI into various sectors, including healthcare, medical devices, and pharmaceuticals, to create a more sustainable and economically vibrant society.[78]
IN8.2 **Address the knowledge gap** in AI, Digital, and Green Economy in the industry.	The knowledge gap in AI, Digital, and Green Economy needs to be addressed to offer a practical skills programme that Malaysia can adopt from the **UK's AI Sector Deal** and **China's New Generation Artificial Intelligence Development Plan**. These strategies outline how to become a global leader in AI and promote its integration across various sectors.[79]
IN8.3 **Provide a range of upskilling training programmes** that cater to various roles within the sector by offering accredited certification courses specifically designed for the Medical Devices sector, focusing on foundational and advanced concepts.	The **Medical Device Quality Management Systems (QMS)** programme provided by NSF International in the US focuses on the foundational elements of quality management systems specific to medical devices, including ISO 13485. Upon completion, participants receive the Certificate in Medical Device QMS.[80] **Foundations of Clinical Trials** provided by Clinical Trials UK provides a foundational understanding of clinical trials for medical devices, including design, execution, and regulatory aspects.[81]

80. European Commission, *Horizon Europe*, <https://research-and-innovation.ec.europa.eu/funding/funding-opportunities/funding-programmes-and-open-calls/horizon-europe_en>
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82. Office for Artificial Intelligence, *AI Sector Deal one year on, July 2019; China's State Council, State Council Notice on the Issuance of the Next Generation Artificial Intelligence Development Plan*, July 2017
83. NSF, Training, <https://www.nsf.org/training>
84. Clinical Trials UK, <https://www.clinicaltrialsuk.co.uk>

Initiatives	Case Studies
IN8.4 **Address the knowledge gap in AI, Digital, and Green Economy in the industry.**	

Benefits
Workforce Empowerment and Adaptability: Enables employees in different positions to enhance and certify their skills in essential, complex areas and cultivate life-long learning. This develops a workforce that is more skilled, adaptable, and ready to address emerging challenges and technologies. **Staying Ahead of Industry Trends:** Capitalising on the transformative power of AI, Digital, and Green Economy to bridge the knowledge gap in these domains will equip employees with the skills to manage sophisticated machinery, interpret complex datasets, and apply eco-friendly methods. **Bridging the Skills Gap in the Sector:** Maintaining a competitive edge by proactively investing and keeping up with advancements will enable the industry to foresee market changes, embrace new technologies, and adopt eco-friendly practices.

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

Top 5 Initiatives

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

1 GOVERNMENT

Invest in various upskilling programmes to enhance workforce capabilities in emerging sectors.

2 GOVERNMENT

Reform the educational curriculum to encourage creativity and align with global best practices, preparing students for future challenges in critical thinking and problem-solving.

3 INDUSTRY PLAYERS

The industry to adopt a proactive approach to retain high-skilled talent and commit to the continuous upskilling of current employees to meet evolving industry needs.

4 ACADEMIA

Strengthen industry partnerships with academic institutions to co-develop internships to expose students to actual industry settings. Ensure syllabus and course content are AI, Digital, and Green Economy-driven which is directly relevant to industry needs.

5 TRAINING PROVIDERS

Government agencies and private trainers to transit from traditional one-way seminars to more integrated workshops that encourage active participation, discussions, and hands-on activities. This fosters a deeper understanding of the material and promotes the practical application of skills.

Conclusion

Malaysia's Medical Devices sector is poised for a transformative shift over the next three (3) to five (5) years, propelled by an evolving global landscape shaped by the advancement of AI, Digital and Green Economy trends within the country's Medical Devices sector. **Contributing RM2 billion to the nation's GDP with RM8.2 billion and RM31.1 billion worth of imports and exports** respectively, the Medical Devices sector must evolve to ensure they can broaden their product ranges into higher-end categories thus further supporting its human resource development, R&D, and regulatory compliance in the long run. This evolution will help strengthen Malaysia's standing among regional and global peers and ensure that the domestic workforce remains robust and capable of meeting shifting industrial needs, congruent to Malaysia's current stellar leadership record as the largest producer and exporter of rubber gloves, **supplying 67% of the world's demand and the second largest producer of rubber thread**.

The focal point of the impact study centres on roles significantly affected by the growth trends of AI, Digital, and Green Economy. Due to these trends, highly impacted roles are significantly impacted by advanced data analysis tools, automation, and digital technologies that enhance testing, predictive maintenance, and manufacturing processes; **within the next three (3) to five (5) years, approximately 21% or 13,000 employees will be facing job risks** based on TalentCorp's Demand Model Projection. Hence, the workforce must be adept at leveraging AI tools to analyse large datasets, predict outcomes, and optimise processes effectively.

The study identified **four (4) emerging roles** that are tailored to future technological advancements, industry trends, and societal changes. By focusing on these emerging roles, organisations can drive innovation, adopt sustainable practices, and remain competitive and compliant with evolving regulations and market demands. **Additionally, the study identified six (6) highly impacted roles, 39 medium impacted roles, and eight (8) low impacted roles**.

Looking ahead, embarking on this journey of continuous adaptation and innovation will be vital in preparing the Medical Devices workforce for ongoing advancements in AI, Digital, and Green Economy. To achieve this, the **MyMAHIR Future Skills Talent Council (FSTC)** will conduct regular needs assessments to identify immediate and future workforce skills gaps, analyse talent demands by sector and educational level, propose strategies, determine essential sector-specific skills, and periodically update these skills in response to technological advancements and evolving operating environments. Additionally, the council will align the educational system with the sector's needs while actively fostering collaboration among government, industry players, academia, and training providers to enhance Malaysia's competitiveness and promote sustainable growth in the Medical Devices sector.

Coordinated efforts and collaboration among all stakeholders—government, industry players, academia, and training providers—are essential. The time to implement the eight (8) Recommended Initiatives is now, as they are intended to develop a workforce that can meet the sector's evolving needs, enhance competitiveness, support sustainable growth, and position the Medical Devices sector as a key driver of national prosperity and international recognition.

Key trends impacting existing roles:

- Artificial Intelligence
- Digital
- Green Economy

The study identified 6 job roles that will be highly impacted by these trends, along with 4 emerging roles, and 10 in-demand skills essential for future advancements.

MyMAHIR Future Skills Talent Council (FSTC)

has been set up to prepare for these changes

Validation Workshop

Validation Workshop

Abbreviations

AI	Artificial Intelligence
AMMI	Association of Malaysian Medical Industries
APAC	Asia Pacific
ARPA-H	Advanced Research Projects Agency for Health - US
ASEAN	Association of Southeast Asian Nations
BD	Becton, Dickinson, and Company - US
BioMARC	Biopharmaceutical Manufacturing and Academic Resource Centre - US
BVMed	German Medical Technology Association
CAGR	Compound Annual Growth Rate
CMDI	Canadian Medical Device Industry
CPTPP	Comprehensive and Progressive Agreement for Trans-Pacific Partnership
CSR	Corporate Social Responsibility
CT	Computed Tomography
CTA	Clinical Trial Administrator
CTMS	Clinical Trial Management System
DDI	Domestic Direct Investments
DES	Drug-eluting Stent
EHR	Electronic Health Records
EHS	Environmental Health and Safety
EMA	European Medicines Agency
EMS	Emergency Medical Services
EMS	Engineering and Manufacturing Support
ESG	Economy, Social and Governance
EU	European Commission
FDA	Food and Drug Administration - US
FDI	Foreign Direct Investments
GDP	Gross Domestic Product
GHG	Greenhouse Gas
GLCs	Government-Linked Companies
ICT	Information and Communications Technologies
IN	Initiatives
IoT	Internet of Things
IPO	Singapore's Biomedical Sciences Industry Partnership Office
IR4.0	The Fourth Industrial Revolution
IVD	In-vitro Diagnostics
KESUMA	Ministry of Human Resources
K-MOOC	Korean Ministry of Employment and Labour
LCA	Life Cycle Assessment
LIMS	Laboratory Information Management Systems
MIDA	Malaysia Investment Development Authority
MNC	Multinational Companies
MRI	Magnetic Resonance Imaging
MS&T	Process Development/Manufacturing Science and Technology
MDEC	Malaysia Digital Economy Corporation
MDEB	Malaysia Digital Economy Blueprint
MyNSR	Malaysia National Skills Registry
NETR	National Energy Transition Roadmap - Malaysia
NGTP	National Green Technology Policy - Malaysia
NIMP 2030	New Industrial Master Plan 2030
NLP	Natural Language Processing
NUS	National University of Singapore
PLCs	Public Listed Companies
PPE	Personal Protective Equipment
QA&QC	Quality Assurance and Quality Control
QMS	Quality Management Systems
R&D	Research and Development
RIMS	Regulatory Information Management Systems
RMKe-12	Twelfth Malaysia Plan
ROI	Return on Investment
SEC	United States Securities and Exchange Commission
SMEs	Small and Medium-sized Enterprises
TalentCorp	Talent Corporation Malaysia Bhd
TUM	Technical University of Munich
TVET	Technical and Vocational Education and Training
VR	Virtual Reality

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