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The Role of Stakeholders in Managing Government Research and Development Funding for Defence Industrial Innovation: The Case of Malaysia

Kogila Balakrishnan and Treesna Nadira Johar

ABSTRACT
The level of defence industrial innovation success has been modest in Malaysia, despite continuous investment into research and development (R&D). The authors use the Defence Research and Development Stakeholder Engagement Framework (DRDSEF) to argue that strategic collaborative engagement between stakeholders is critical for successful industrial and technological innovation. This paper has two aims: to describe the role of the stakeholders in managing defence R&D funding and to evaluate the challenges faced by these stakeholders in managing government defence R&D allocation for industrial and technological innovation. This is an exploratory case study using a combination of interpretivist and pragmatist philosophical approaches. Analysed data consists of secondary resources and primary resources included surveys in the form of open-ended semi-structured interviews and participatory observation. This paper concludes that successful defence R&D stakeholder engagement requires an open and independent platform, enhanced industry-academia cross-sector fertilisation and collaborative data analytics management tools to share information.

Introduction

R&D spending on defence innovation is not a subject that receives significant attention in Malaysia. It is often seen as either confidential defence information or nonvital for a small non-weapons-producing country. Further, there is a lack of public awareness on such a complex topic associated with national security. It is also challenging to obtain published data on Malaysian defence R&D and innovation, and there is a dearth of research publications or articles in the public domain on this subject. Fortunately, a handful of unpublished government reports and cabinet papers have reported on the outcome of the Malaysian R&D defence spending. Hence the current research is a valuable addition to the body of literature in defence R&D, especially for small developing nations with limited R&D budgets.

Innovation in this paper is defined as the creation and application of new products, services processes, and ideas from the earliest stages of inception to impact (economic, social) (Budden and Murray 2019). Innovation encompasses a new way of doing things and includes the process of invention. In the context of defence innovation, it is mainly about ensuring that new ideas are applied to the benefit of end-users. Malaysia’s commitment to invest in R&D for innovation and productivity was spurred by success stories of East Asian countries such as Japan, South Korea, and Taiwan in the 1990s. Malaysia wanted to transition from an input-driven to a knowledge-based economy with high-technology industries (Jomo and Felker 1999; Jomo, Felker, and Rasiah 1999;...
Economic Planning Unit 2010). The defence and strategic sectors were identified as crucial catalysts to build indigenous capability in critical emerging technologies, through various technology transfer modes.

**Malaysia’s Defence R&D Investment**

From the 1960s, the Malaysian government has invested considerably towards defence R&D for the development of the MDI sector and specifically for the development of the Defence Technical Centre (DTC), later known as the Science and Technology Research Institute for Defence or STRIDE (Wan Hanafi 2021; MINDEF 2020; STRIDE 2016).

Table 1 illustrates the Malaysian government’s budget allocation to STRIDE between the 8th and 11th Malaysia Plan (MP). STRIDE’s budget demonstrates that R&D allocation has followed a cyclical trend but increased significantly from USD2.32 million under the 10th MP (2011-2015) to USD4.22 million under the 11th MP (2016-2020). The budget allocation is expected to stay at USD4.22 million under the 12th Malaysian Plan (2021-2025). The prior allocation increase was attributed to the increasing emphasis on R&D by the Malaysian government for defence industrial and technological growth (Wan Hanafi 2021).

Although Malaysia’s defence budget allocation has been on the rise, it remains relatively small when compared to the defence R&D spending of other countries in the region, as shown in Table 2.

The Defence White Paper (DWP) (MINDEF 2020) and the Defence Industry Blueprint (2005) describe Malaysia’s commitment to R&D investment to develop defence science, technology, and industry capabilities. The DWP states that the primary objective of embracing defence R&D is to prepare the Malaysian defence industry for developing the targeted capacity to design, test, develop and market dual-use and defence technologies for both the domestic and export markets, especially in the ASEAN region (MINDEF 2020; Bitzinger 2015). Malaysia must view investment into R&D and leading in innovation as critical if it wants to stay relevant as a leading member of ASEAN and the region (Wan Salleh 2019; MINDEFb 2019). While the Malaysian government has continuously funded defence R&D projects through MINDEF’s budget allocation, a recent review of the 2005 Defence Industry Blueprint identified several reasons for the lack of defence industrial innovation within the MDI sector (Malaysian Industry-Government Group for High Technology (MIGHT) 2021; STRIDE 2021, MINDEFc 2021). This research aims to further substantiate the argument and identifies three key challenges.

### Table 1. Comparison of Malaysia’s defence government R&D budget.

<table>
<thead>
<tr>
<th>Malaysia Plan</th>
<th>8th</th>
<th>9th</th>
<th>10th</th>
<th>11th</th>
<th>12th</th>
</tr>
</thead>
<tbody>
<tr>
<td>STRIDE R&amp;D Budget (RM mil)</td>
<td>2.2</td>
<td>17.5</td>
<td>9.8</td>
<td>17.8</td>
<td>17.8*</td>
</tr>
<tr>
<td>USD (mil)</td>
<td>0.52</td>
<td>4.15</td>
<td>2.32</td>
<td>4.22</td>
<td>4.22</td>
</tr>
</tbody>
</table>

Sources: Wan Hanafi (2021); STRIDE (2020) * Approximate figures under the First Rolling Plan of the 12th Malaysia Plan

### Table 2. Comparison of Malaysia’s defence R&D allocation against various countries.

<table>
<thead>
<tr>
<th>Country</th>
<th>Defence R&amp;D Spending based on the latest information (USD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Japan</td>
<td>2.64 billion for 2022a</td>
</tr>
<tr>
<td>South Korea</td>
<td>4.14 billion for 2022b</td>
</tr>
<tr>
<td>Singapore</td>
<td>425 million for 2021c</td>
</tr>
<tr>
<td>Malaysia</td>
<td>4.22 million</td>
</tr>
</tbody>
</table>

Sources: a nippon.com 2021; b (Grevatt and MacDonald 2021); c Global data 2021; d Wan Hanafi 2021
Challenges to Achieving Defence Industrial Innovation

Malaysia still imports most of its defence equipment and services (Malaysian Industry-Government Group for High Technology (MIGHT) 2021; Interviewee GOVT1 2020). Malaysia ranked 40th for global arms imports between 2016-2020 and accounted for 0.5% of total global arms imports, showing an increase of 114% between 2011-2015 and 2016-2020. The largest arms supplier to Malaysia is Spain (32% of imports), followed by Turkey (17%) and South Korea (11%) (MINDEFb). This high level of import stems from Malaysia’s insufficiently mature defence industrial and technological capability base that is unable to fully cater to the domestic market, especially to the needs of the Malaysian Armed Forces and other security organisations. The government, especially the defence and security sector, wants to prop up the MDI sector to increase their technological absorptive capacity and capability to cater to the local defence and security market instead of being wholly dependent on OEMs.

The lack of strategic intent towards developing a structured defence R&D policy was identified as one of the key impediments in attaining a higher level of defence industrial innovation (Interviewee AC1 2021; Interviewee AC2 2020; Interviewee GOVT1 2020; Interviewee GOVT2 2020; Interviewee IND1 2020; Interviewee IND2 2020; Interviewee EU1 2019). There is an absence of a national defence R&D policy that specifies defence R&D objectives, a technology roadmap, the role of various stakeholders, terms of reference, and an implementation protocol. The absence of such an important document has led to uncertainty in stakeholders’ commitments to funding and investing in defence R&D (Interviewee AC1 2021; Interviewee GOVT1 2020; Interviewee GOVT2 2020; Interviewee IND2 2020). Stakeholders play a significant role in ensuring the successful management of defence R&D allocation. Stakeholders include the government, end-users, research organisations, venture capitalists (VC), and industry. The stakeholders are defined as the Ministry of Defence (government), STRIDE (government research organisation), Malaysian Armed Forces (end-users), the National Defence University Malaysia or NDUM (academia), and the MDI sector (industry). These stakeholders have mentioned concern over the lack of innovation outcome from the local defence industrial sector despite the investment into R&D (STRIDE 2021; MINDEFb 2021; MINDEFC 2021).

NDUM tried developing a National Defence Research and Security Blueprint in 2014. Still, the implementation of the blueprint failed as there was a lack of interest and buy-in from the various stakeholders (Singh 2019). This also raised the question of whether there was full support from all stakeholders for NDUM’s leadership in developing the blueprint, and whether NDUM itself made sufficient efforts to obtain the buy-in and engage key stakeholders in the process (Singh 2019).

The increasing gap in research skills possessed by local researchers, especially in very niche areas of technology specialisation, is another reason for the low level of successful industrial innovation outcomes. Table 3 reflects Malaysia’s increasing R&D personnel and researchers, at 28 researchers per 10,000 members of the labour force in 2008 compared to 74 per 10,000 in 2016 (Mastic n.d.). However, Table 3 also shows that Malaysia’s ratio of researchers to total population is still proportionally low when compared to other industrialised countries in the region.

In the context of Malaysia’s defence R&D researchers, Table 4 illustrates STRIDE’s researcher capacity when compared to other countries. STRIDE’s 165 researchers are very low in comparison to other defence research agencies around the world (Wan Hanafi 2021).

<table>
<thead>
<tr>
<th>Country</th>
<th>2015</th>
<th>2016</th>
<th>2017</th>
<th>2018</th>
</tr>
</thead>
<tbody>
<tr>
<td>China</td>
<td>1150</td>
<td>1196</td>
<td>1224</td>
<td>1307</td>
</tr>
<tr>
<td>Indonesia</td>
<td>n.a.</td>
<td>178</td>
<td>215</td>
<td>215</td>
</tr>
<tr>
<td>Japan</td>
<td>5173</td>
<td>5209</td>
<td>5304</td>
<td>5331</td>
</tr>
<tr>
<td>Malaysia</td>
<td>2308</td>
<td>2396</td>
<td>n.a.</td>
<td>2184</td>
</tr>
<tr>
<td>Republic of Korea</td>
<td>7013</td>
<td>7086</td>
<td>7497</td>
<td>7980</td>
</tr>
<tr>
<td>Singapore</td>
<td>7006</td>
<td>6935</td>
<td>6802</td>
<td>n.a.</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>4319</td>
<td>4357</td>
<td>4341</td>
<td>4603</td>
</tr>
</tbody>
</table>

Source: World Bank Website.
Further, these researchers must have the appropriate qualifications, experience, and training to undertake fundamental and applied research skilfully. Organisations that have acquired a research portfolio must understand that they have committed to additional costs and risks, and that investments into R&D do not always yield successful returns (Interviewee AC1 2021; Interviewee GOVT2 2020; Interviewee IND2 2020). Since research is experimental, organisations must appreciate the value of researchers learning from the research process, regardless of the outcome. Hence, when there is a lack of commitment towards investing in research skill development, there is a danger that the skills gap could further widen, resulting in a dearth of local research scientists and engineers who can undertake independent collaborative research activities (Interviewee IND2 Interviewee GOVT2 2020). This resource is underutilised, as there is a lack of stakeholder engagement in identifying, exploiting, and sharing available resources to fill in the research gaps or even undertake collaborative research projects. Further, there is a lack of consultation between the government, MDI and the academic community in deciding the appropriate type and level of education and research that is required to build the necessary skills within the MDI sector (Interviewee GOVT1 2020).

The other major issue is the lack of R&D investment by the MDI sector into enhancing their innovative capabilities, in turn affecting long-term industrial productivity and competitiveness. Investments into R&D are expensive. OEMs may not always be able to give away their intellectual property rights (IPR) and risk competition. There is often tension in the buyer-supplier relationship, namely between building a long-term sustainable and trustworthy partnership that results in healthy technology transfer, and trying to take shortcuts with a short-term view, such as reverse-engineering methods.

During a defence industry plenary session with key stakeholders, the Secretary-General of the MINDEF expressed his views that the lack of defence R&D stakeholder engagement and strategic alignment between them have been significant challenges in delivering successful outcomes in industrial innovation (MINDEFa 2021). The 2005 Defence Industry Blueprint also identified the issue of poor stakeholder engagement in managing the defence R&D environment, resulting in an inability to realise greater innovation outcomes (MINDEF 2005).

Hence, the question arises as to how stakeholder collaboration can be encouraged in managing government defence R&D allocation for enhanced defence industrial innovation. This paper attempts to describe the role of the stakeholders in managing defence R&D allocation. This research paper also uses the Defence Research and Development Stakeholder Engagement Framework (DRDSEF) to critically evaluate the challenges faced by the stakeholders’ in managing defence R&D allocation. However, the framework is not a ‘one-size-fits-all’ and needs to be adapted and localised to the context of each country. The factors to be considered include the size of the R&D budget allocation, the breadth and depth of the roles and responsibilities of the relevant stakeholders, and the capabilities of the indigenous defence industry. Additionally, several recommendations are suggested to enhance R&D stakeholders’ alignment and engagement.
**R&D Stakeholder Engagement in Delivering Industrial Innovation**

The concept of stakeholders has become central in the field of management and defence economics. It is important for an organisation to map stakeholder interest to identify the key decision-makers and evaluate where to allocate limited resources, besides considering other factors such as opportunities, risks and performance that help in delivering national or organisational effectiveness and efficiency. Nevertheless, there is a lack of common consensus regarding the concept of a stakeholder. This word ‘stakeholder’ has its roots in business science literature and can be traced back to Adam Smith and his ‘Theory of Moral Sentiments.’ The currently utilised definition goes back to the 1960s when the Stanford Research Institute introduced the term to generalise and expand the notion of stakeholders as the only group that management needed to be sensitive towards. Freeman (1984) proposed that organisations must also consider the interest of other stakeholders when taking strategic decisions, such as of the CEO, board members, directors and senior and middle management, relating his statement to the issue of ‘who said what.’ Freeman argued that a stakeholder consists of ‘any group or individual who can affect or is affected by achieving the firm’s objectives.’ The concept underpins the fact that an organisation will not survive without the support of these key groups (Schutz, Heidingsfelder, and Schraudner 2019).

Several models have been used to explain the importance of stakeholder management. The ‘triple helix model’ introduced by Etzkowitz and Leydesdorff (1995) established that the university-industry-government interaction is a framework that leads to expanded knowledge and resources. Carayannis and Campbell (2009) later expanded on the triple helix model by introducing the end-user or society as an additional element, naming this extended model the ‘quadruple helix model’. Both these models emphasise the significance of linkage, collaboration, co-existence and co-evolution between stakeholders. Knowledge transfer, production, and co-specialisation of different knowledge paradigms become essential in co-existence and co-evolution. Each stakeholder plays a significant role in the innovation process where no single party is more important than another (Carayannis and Campbell 2009).

Collaboration becomes a key ethical consideration in stakeholder management. These include accessing external resources and proprietary assets that increase capacity and speed up discovery time or material production. Stakeholder collaboration can also reduce technological, market, financial and operational risk, thus improving actors’ abilities to meet organisational challenges (Scandura 2016; Lee and Kim 2016; Doret and Johan 2014; Guimon 2013; Hamel and Prahalad 2005; Hagedoorn, Link, and Vonortas 2000). Collaboration may also stimulate networking, leading to more investment and better infrastructure that can drive business earnings and create highly skilled jobs. This in turn increases the national level of intellectual capital. A few examples of these include the establishment of business and science parks around the world, such as the Research Triangle Park in North Carolina; East River Science Park in the Manhattan; Toronto’s Discovery District; Boston’s Kendall Square; Hyderabad’s Genome Valley (Corzo 2015); and Singapore’s R&D ecosystem known as One-North (Chow 2015). Collaboration promotes shared risk, cost reduction (through shared costs), and enhanced productivity (Lqbal 2013; Salleh and Omar 2013; Hagedoorn, Link, and Vonortas 2000). This deepens research competencies and increases the national research capacity, opening opportunities for skills development through education and training for university students and faculty professionals. Economists often introduce game theory to test stakeholder collaboration. These theories have become increasingly popular in business management studies to demonstrate the consequences and outcomes arising from stakeholder collaboration (Myerson 1991; Osborne and Rubinstein 1994).

In the context of this paper, we focus on the role of stakeholder collaboration in managing R&D allocation for enhancing industrial innovation. There are various stakeholders involved in the R&D network and related interactions, commonly identified as the government; the industry; academia; and the end-user/society (Hasche, Hoglund, and Linton 2019; Setyanti 2017; Carayannis and Campbell 2009; Etzkowitz and Leydesdorff 1995). R&D stakeholders are a critical aspect of R&D
management, associated with the concept of partnership infrastructure (Elias, Cavana, and Jackson 2002). The representation of stakeholders in an R&D environment can be broad, covering the government or public institutions (from various levels including cities, local, regional and national policy), private sector organisations (including start-ups, SMEs, corporations), academia (universities, research organisations), and citizens or end-users (Setyanti 2017).

Successful stakeholder collaboration in managing R&D allocation is critical for industrial innovation outcomes. There is a dearth of publications on the role of stakeholders in managing R&D allocation for defence innovation. A recent report by MIT on defence innovation identified five key stakeholders which go beyond the triple helix and quadruple helix model. Figure 1 expands discussion past private, government, corporations (military-industrial relations) and universities to include the entrepreneurial community or risk capital providers who access and fund their ventures, including venture capitalists (VCs) (Budden and Murray 2019). The report argues that VC clusters are successful in countries with an open market environment. The report also suggests that innovation tends to be more successful in geographically concentrated and bounded hubs, and ecosystems with the right blend of inputs combined with talent and incentives. Examples include the Silicon Valley, Boston, and Austin in the US and UK hubs like Cambridge, Sheffield, and London (Budden and Murray 2019). Nevertheless, the idea of VCs funding R&D for innovation in small developing states remains a rarely occurring and remote prospect. In this case, success stories of countries such as Singapore and Israel in using R&D for innovation are unique, mainly attributed to their industrial and technological absorption capability, and economic prowess. Most small developing countries are still heavily dependent on governmental support to undertake defence research.

Government actors play a significant role in the innovation space. Figure 1 for national security and defence focuses on growth (scale-up and expansion, export promotion), human capital, and talent. The model focuses on innovation-driven entrepreneurship and start-ups. Figure 1 argues that traditional inputs consisting of R&D funding alone are insufficient, and that desired innovation outcomes cannot be achieved by simply increasing R&D funding. The model recommends the enhancement of entrepreneurship, encouraging enterprise-formation (start-ups), and creating business rules (Budden and Murray 2019). Similarly, a RAND Corporation report mentioned that the UK Innovation model emphasises the importance of innovation through engagement with external

Figure 1. An MIT Approach to Innovation: ecosystems, capacities & stakeholders. Source: Budden and Murray (2019), pp. 7.
sources, creation and participation in innovation networks, and creation of innovation spaces (Freeman et al. 2015). However, the report also mentions that the Ministry of Defence environment has not been conducive to effectively exploit external stakeholders. The report acknowledged that innovation is challenging in a defence environment due to a closed culture, sensitivity, and secrecy around defence.

However, the motivation to innovate is essential, and this may be stimulated through incentivisation for enhancing military capabilities for end-users and profits for the defence industry. At the same time, a nation that wants to invest in R&D for industrial innovation must have the necessary resources such as raw materials, capital, assets, talents, and skills. Other considerations include having adequate infrastructure, networks, and connectivity (Freeman et al. 2015). On some occasions, innovation flourishes when facilities such as research hubs that provide physical space are created (Freeman et al. 2015).

Innovation culture, which is open, trusting, and conducive to risk-taking and learning from failure, must exist in the defence industrial environment. It is also important to promote leadership that is future-oriented and willing to support and create solutions instead of an overly bureaucratic organisation. Innovation is essential in the defence sector to exploit existing products and adapt readymade and rapid impact solutions (Budden and Murray 2019). Innovation is also crucial to counter potential adversaries with more advanced defensive and offensive capabilities (Louth, Taylor, and Tyler 2017).

Based on the various established models and the MIT diagram as per Figure 1, we introduce the Defence Research and Development Stakeholder Engagement Framework or DRDSEF. This model is limited to stakeholders involved in government-funded R&D. The model does not consider other types of funding such as from foreign suppliers or sources such as offsets, foreign direct investments, joint-ventures, indigenous private companies, or VCs. Emulating the quadruple helix, the DRDSEF model as in Figure 2 has identified four stakeholders – the government, which is MINDEF Malaysia and STRIDE; users, the Malaysian Armed forces; universities, focusing on the National Defence University Malaysia (NDUM); and the private sector that is the Malaysian defence industry. This paper uses the DRDSEF model (Figure 2) to analyse the role of Malaysian stakeholders in the defence R&D environment, discuss potential challenges, and develop policy suggestions on how to enhance stakeholder collaboration for defence industrial innovation. This model cannot be generalised and is specific to the context of Malaysia.

In the Malaysian context, the DWP recognises defence R&D as one of the key national defence policy objectives, and Malaysia continues to invest in defence R&D as part of the national defence policy and industrial defence strategy (MINDEF 2020). Defence R&D allocation is used to research both defence and dual-use technologies. The aim is to develop a local defence industrial base that

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**Figure 2.** The Defence Research and Development Stakeholder Engagement Framework (DRDSEF. Source: Authors.
has the capability to innovate (MINDEF 2020, 2010). Malaysia requires a rapid shift to enable its defence industries to innovate for several reasons. Malaysia also needs to find its military technology and industrial capability niche, so innovation is vital. There is an urgent need to develop superior skills, knowledge, intelligence, information, and technology to better protect the state. Capabilities such as integration of platforms and systems in new ways, pursuing benchmarks of operational efficiency, automation, networking, and disruptive military technology are critical. Some of these technologies include robotics, artificial intelligence, machine learning, cyber, state-of-the-art sensors, power, energy management, improvements in detection and tracking, as well as quantum technologies, systems engineering and technology evaluation. The following section briefly explains the research design and methods used to undertake this study.

Research Methodology

This is exploratory research addressing real-world problems. The research question sprung from a focus on enhancing stakeholder collaboration to deliver defence industrial innovation and employed a case-study approach, using the context of a small developing middle-income country, Malaysia (Abdullah 2019; Yin 2018). This research uses a qualitative approach to explore the broader challenges for industrial innovation in Malaysia and the role of the multiple stakeholders involved in managing government defence R&D allocation. The final objective was to develop a list of recommendations on measures that could be employed to improve collaborative defence R&D stakeholder engagement. Data was gathered using multiple sources. Secondary data included journal articles, books, policy documents, government reports, and company reports. Primary sources included data collected from in-depth interviews using a semi-structured questionnaire (Abdullah 2019; Creswell 2014). The semi-structured questionnaire focused on stakeholder role, stakeholder issues and challenges, and stakeholder response to improving defence R&D collaborative management.

The units of analysis for the interview were identified from four stakeholder groups within the MDI, namely the government, end-users, industry players, and academia. Forty interviewees were identified from a pool of potential stakeholders from the Council for Malaysian Industry Group for Defence and Security (MIDES) list. Participants were individuals operating at strategic and decision-making levels, mainly senior managers who had substantive knowledge and experience in defence R&D management. Four pilot studies were conducted with two participants: a government respondent, who was the head of the department responsible for MDI policies and implementation, and an industry respondent, the Chief Operating Officer of a large MDI company, over a one-week period. A set of questionnaires was emailed to them to test-retest the reliability and robustness of the questions (Lavrakas 2008). Both volunteer participants’ answers were stable and consistent. The questionnaire was sent out via email to 40 participants with clear instructions and notes explaining the research background and what is expected of them, along with a request for interview slots with prospective participants. 12 out of 40 participants responded. Table 5 describes the participants and their backgrounds. Researchers obtained prior written approval from the participants for the

<table>
<thead>
<tr>
<th>Stakeholder Segment</th>
<th>Description of Respondents’ Role</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>End-User</td>
<td>A full colonel with vast experience in military combat; and offset management</td>
<td>EU1</td>
</tr>
<tr>
<td>End-User</td>
<td>A full colonel with experience in military logistics and operations to support MAF</td>
<td>EU2</td>
</tr>
<tr>
<td>Academia</td>
<td>A high-level official leading in research and Innovation in a University</td>
<td>AC1</td>
</tr>
<tr>
<td>Academia</td>
<td>A senior lecturer in a university who was also involved in the development of Malaysia Defence</td>
<td>AC2</td>
</tr>
<tr>
<td>Government</td>
<td>A senior management who oversees defence industry</td>
<td>GOVT1</td>
</tr>
<tr>
<td>Government</td>
<td>A senior management who oversees defence science</td>
<td>GOVT2</td>
</tr>
<tr>
<td>Industry</td>
<td>A COO of a defence-oriented company in the aerospace sector</td>
<td>IND1</td>
</tr>
<tr>
<td>Industry</td>
<td>A senior manager of a defence-oriented company in the automotive sector</td>
<td>IND2</td>
</tr>
</tbody>
</table>
interviews to be recorded and transcribed for accuracy. The email was sent out with a consent note detailing the ethical processes and researchers’ responsibility to safeguard participants’ identities. The respondents’ identities and actual names and positions have been anonymised to protect their confidentiality in line with General Data Protection Regulation (GDPR) and data protection compliance. The participants were informed in advance that their information would be kept confidential, and all transcripts would be destroyed after the paper was published.

Eight out of 12 respondents were successfully interviewed. This was due to the sudden outbreak of COVID-19, which made it impossible for the researchers to meet face-to-face or secure online appointments with several participants. The researchers acknowledge the limitations arising from the below 50% response level. This low level of response and participation was also compounded due to the problematic nature of getting access to defence-related data. The researchers acknowledge the limitations and unconscious biases stemming from the limited responses may impact the validity and reliability of the research outcome. However, we argue that the poor response was balanced by extremely rich and in-depth input captured from the eight participants. Further, the researchers as practitioners in the field have used a pragmatic inductive participatory observation approach to cross check and validate the collected data for reliability and accuracy.

The literature and documents were analysed using the thematic analysis method, while the interview findings were analysed using the content analysis. Thematic analysis was done conceptually, looking at several identified terms including defence R&D; stakeholder; engagement; collaboration; challenges; critical success factors; and recommendations. On content analysis, themes were identified based on the literature review and the interview findings. Data was standardised, and findings from similar topics were grouped, analysed, and interpreted by identifying possible relationships that could exist related to the research question (Braun and Clarke 2006; Seidman 1998).

The Malaysian Defence R&D Stakeholders

As mentioned previously, there are several key stakeholders managing defence R&D in Malaysia. In the government, these consist primarily of MINDEF, including a dedicated division relating closely to the development of the MDI – the Defence Industry Division (DID) – and STRIDE. Other crucial stakeholders include the end-users (MAF), academia (which consists of NDUM and a few other universities), and finally the MDI companies. In this section, we describe the role of the stakeholders and how they support the development of the defence R&D eco-system in Malaysia.

The Government (MINDEF and STRIDE)

Defence Industry Division, MINDEF (DID)

MINDEF is a key stakeholder in managing defence R&D allocation. DID is the most important organisation in managing the policy and implementation of the MDI. DID was instrumental in developing the Malaysian Defence Industry Blueprint (2005), the Defence Offsets Policy (2005), the Industrial Collaboration Policy or ICP (2011), the long-term contract policy, and the Economic Enhancement Policy (2010). DID was also deeply involved in the drafting of the Defence White Paper, particularly chapter seven that highlights the Government’s strategic intention and focus in developing the defence industry to support military capability and as a contributing factor to economic growth and prosperity. Since 2021, Fundamentally, DID is the main secretariat of MIDES, a key platform established by the government to navigate policies supporting the MDI.

STRIDE

STRIDE is a government defence research outfit that was established in 1968 and remains the key contributor in supporting the growth of defence science in Malaysia (Wan Hanafi 2021; STRIDE 2016). The primary function of STRIDE is to conduct defence R&D and to provide MINDEF with defence science and technology support such as technical services and consultation. STRIDE was initially
known as the Defence Technical Centre or DTC. DTC was only responsible for supporting the MAF and MINDEF in specifically developing and endorsing technical specifications, testing, evaluation, and investigation. The role and function of DTC were further expanded in 2002 to incorporate defence R&D.

STRIDE’s current organisational support is divided into technical and advisory services. Table 6 reflects the recent breakdown of STRIDE’s R&D personnel. Of the 268 STRIDE personnel, 135 or approximately 50% of the staff are directly involved in R&D activities (i.e. the Q scheme personnel). The bulk of STRIDE’s capability focuses on certification of defence products (50%) for the MAF. The remaining capability is divided between defence R&D activities (35%) and technical consultation-related activities (15%) (Wan Hanafi 2021). STRIDE focuses on protective and biophysical technology; weapon technology; maritime technology; instrumentation and electronics technology; and mechanical and aerospace technology (Wan Hanafi 2021). STRIDE’s role is seen as crucial in supporting the MAF and other security agencies to obtain high-quality assets through testing and research (STRIDE 2016).

STRIDE receives R&D allocations through several government channels, either directly through MINDEF budget allocation, government procurement programs, or ICP. STRIDE’s other roles include acting as Malaysia’s technical agency for the Biotoxin Weapon Convention under the Geneva Convention; participation in the European Union Chemical Biological Radiological and Nuclear Risk Mitigation Centres of Excellence Initiative (EU-CBRN COE) Project 46; collaboration with Department of Defence US and the US centres for Disease Control and Prevention (USCDC); and training for the Royal Malaysia Police and Ministry of Health officials to investigate deliberate bio-incidents in 2018. STRIDE is also exploring research, development and innovation (R&D&I) collaboration opportunities with the Centre of Science and Technology Research and Development in Brunei on uniform testing, and with Pakistan on Tropicalisation Test Centre (STRIDE Interviewee 2021).

**Table 6. STRIDE Personnel Breakdown.**

<table>
<thead>
<tr>
<th>POST</th>
<th>QUANTITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Premier Grade B</td>
<td>1</td>
</tr>
<tr>
<td>Premier Grade C</td>
<td>2</td>
</tr>
<tr>
<td>Management &amp; Professional Q Scheme</td>
<td>78</td>
</tr>
<tr>
<td>Management &amp; Professional Non-Q Scheme</td>
<td>8</td>
</tr>
<tr>
<td>Support 1 Q Scheme</td>
<td>54</td>
</tr>
<tr>
<td>Support 1 Non-Q Scheme</td>
<td>89</td>
</tr>
<tr>
<td>Support 2 Non-Q Scheme Q</td>
<td>33</td>
</tr>
<tr>
<td>MAF</td>
<td>3</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>268</strong></td>
</tr>
</tbody>
</table>

Source: STRIDE (2021)

The end-user (The MAF)

The MAF is another key stakeholder with a strong interest in issues involving defence R&D in Malaysia. The MAF’s role is to outline the requirement and specification of defence products based on the needs and perspective of the end-user; to test the defence products and prototype; and to provide their inputs as the end-user of defence products to the developer of the product and prototype. The MAF also provide input to existing defence products and how they want the developed product to be modified to suit the local MAF requirements (Interviewee EU1 2019; Interviewee EU2 2019). Feedback from the MAF is critical to ensure that companies’ products and prototypes are developed and tested based on the standard and requirements of the end-user. Effective communication would ensure no mismatch in terms of what is expected of the defence science agencies from the end-users. The Defence Industry policy aims to develop competencies based on the needs and requirements of the MAF in the event Malaysia is faced with sanctions or embargos.
**Academia (NDUM)**

The academic community plays a critical part in advancing Malaysia’s defence R&D activities in Malaysia. The National Defence University Malaysia (NDUM) is the leading educational institution that focuses on defence R&D,\(^2\) although it is not currently on the list of the leading research universities identified by the Malaysian Ministry of Education (Yaakob 2021; Juhary 2012).\(^3\) Regarding NDUM, several successful research outcomes have led to several patents identified to be enhanced for commercialisation (Yaakob 2021; Interviewee AC1 2021). NDUM was also instrumental in setting up the Centre for Defence Research and Technology (CODRAT) in 2009 which acted as a collaborative platform between MINDEF and other government and private agencies that focused on niche critical defence research, development and commercialisation (R&D&C) (Interviewee AC1 2021; Singh 2019). NDUM was also instrumental in publishing the National Defence Research and Security Blueprint (NDRC) in 2014 (Singh 2019). NDUM has also been one of the critical benefactors of defence research and education projects derived from ICP programs (Interviewee Interviewee Defence Industry Division 2021). NDUM research activities include collaboration between NDUM, DEFTECH (the subsidiary company of DRB HICOM), and the MAF on Unmanned Ground Vehicles (Interviewee DEFTECH 2021) and sniper rifle R&D programs currently ongoing between Advanced Defence Systems (ADS) and NDUM (Interviewee ADS 2021; Defence Industry Division 2021). NDUM has also collaborated with universities and industries globally, including with the University of Warwick and Cranfield University in the United Kingdom, and Ecole Centrale de Nantes, France (Interviewee NDUM 2021) in education and research. Other research collaborations include study between Universiti Teknologi Malaysia (UTM) and DCNS on the Ocean Thermal Energy Conversion (OTEC) on the island of Pulau Layang-Layang (Defence Industry Division 2021); as well as collaboration between DEFTECH and Universiti Tun Hussein Onn on unmanned aerial vehicle (UAV) Vertical Take-off and Landing, which is currently at the laboratory testing stage (Interviewee DEFTECH 2021). These collaborations are highly emphasised by NDUM as avenues to ensure that universities continue to support the aspiration of the country towards self-reliance (Mohamad Nor 2021).

**The Malaysian Defence Industry (MDI)**

The MDI sector is another major stakeholder in defence R&D management. Malaysia established its defence industrial base in the 1970s mainly to support, maintain, repair, and service the MAF’s equipment (MINDEF 2020; Wan Salleh 2019; MINDEF 2010). The MDI sector has evolved to develop industrial capabilities covering the engineering spectrum, including design, manufacturing, co-production, sub-contracting, licensing, assembly, and maintenance, repair and overhaul (MRO) (MINDEF 2020; Defence Industry Division 2020; Wan Salleh 2019).

MIDES unites all key defence stakeholders to discuss the opportunities and challenges facing the MDI sector. MIDES then forwards policy recommendations that support growth and discusses future opportunities for this sector. MIDES often addresses issues related to defence R&D and technology priorities (Defence Industry Division 2020). MIDES consists of six segments: Aerospace, Maritime, Weapons, Automotive, ICT and Common User Items. Currently 70 MDI companies are members of MIDES (as of January 2021). Table 7 illustrates the current state of defence R&D collaboration by the MDI companies (Interviewee Interviewee Defence Industry Division 2021).

Companies like ATSC Aerospace, DEFTECH, UMW Aerospace and MILDEF have been involved in collaborative R&D projects. For example, ATSC collaborated with IME Technology from Belarus to produce overhaul task cards for SU-MKM aircraft. These locally developed, designed, reviewed and approved task cards were then regulated by Directorate General Technical Airworthiness, leading ATSC to be recognised for a 10-Year Preventive Restoration Works and enabled ATSC to realise the benefit of creating overhaul manuals for Sukhoi aircraft, a process altogether expected to save the Malaysian government up to RM1.2 billion.
Other examples include the DEFTECH collaboration with NDUM on an R&D project to develop unmanned ground vehicles. UMW Aerospace became a tier one supplier to Rolls Royce and collaborated in R&D on product development and the manufacture of fan cases for the Rolls Royce Trent 1000 and 7000 civil aerospace engine programmes. MILDEF is collaborating with STRIDE to develop a 4 × 4 armoured vehicle prototype. The Tarantula 4 × 4 vehicle is intended to replace the RPZ Condor 4 × 4 wheeled armoured personnel carrier fleet that has been in service with the Malaysian Army since 1981.

This section summarised the individual stakeholders and their role in managing the Malaysian defence R&D environment. It was highly challenging to obtain all information pertinent to the R&D projects run by the various stakeholders, primarily due to the security sensitivity of these projects.

Table 7. Examples of defence R&D collaboration by the MDI companies.

<table>
<thead>
<tr>
<th>NAME OF CO. AND SECTOR</th>
<th>NAME OF COLLABORATIVE R&amp;D PROJECT</th>
<th>COLLABORATION PARTNERS</th>
<th>BRIEF INFO ABOUT COLLABORATIVE RESEARCH</th>
<th>TYPE OF R&amp;D</th>
<th>REFERENCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>ATSC Aerospace</td>
<td>Overhaul Task Cards SU-30MKM Multi Role Combat Aircraft</td>
<td>Belarus company, IME Technology; Malaysian companies such as Caidmark and Epic Aero; UiTM, DGT Malaysia. PUSPEKA and STRIDE (ATSC, 2019)</td>
<td>Creation of an overhaul manual for Sukhoi aircraft that saved the country up to RM1.2 billion. The collaborative R&amp;D project also enabled ATSC to penetrate other prospective markets such as Algeria, Indonesia, and Vietnam (ATSC, 2019)</td>
<td>Development of innovative product</td>
<td>Interviewee, ATSC (2019)</td>
</tr>
<tr>
<td>DEFTECH Automotive</td>
<td>Unmanned Ground Vehicle R&amp;D Project</td>
<td>End-user. DEFTECH; and NDUM</td>
<td>NDMU grant for this research program is conditional upon DEFTECH using the outcome of the completed Unmanned Ground Vehicle</td>
<td>Research and Product Development</td>
<td>Interviewee DEFTECH (2021)</td>
</tr>
<tr>
<td>OpenApps ICT</td>
<td>Mobile Adhoc Network (MANET) technology for radio</td>
<td>Savronik, Viast, MIMOS and Universiti Malaysia Pahang</td>
<td>The collaboration is still ongoing</td>
<td></td>
<td>Interviewee OpenApps (2021)</td>
</tr>
<tr>
<td>UMW Aerospace</td>
<td>Manufacturing and supply of fan cases for the Rolls-Royce Trent 1000 and Trent 7000 civil aerospace engine programmes</td>
<td>Rolls-Royce</td>
<td>Transfer of technology/market access/human capital development related to advanced manufacturing and supply of fan case for Rolls-Royce. The collaboration ended in UMW becoming a Rolls-Royce long-term strategic partner</td>
<td>Product Development</td>
<td>Interviewee Defence Industry Division (2021)</td>
</tr>
<tr>
<td>MILDEF</td>
<td>4x4 High Mobility Armoured Vehicle</td>
<td>End user STRIDE</td>
<td>MILDEF revealed the 4 × 4 HMAV prototype in February 2021. Production is expected to commence in the first quarter of 2022</td>
<td>Research, Product Development, Testing</td>
<td>Army Technology.</td>
</tr>
</tbody>
</table>

Source: Defence Industry Division (2021)
Stakeholder Challenges in Managing Defence R&D

Government (MINDEF and STRIDE)
The research results indicate that MINDEF has the strongest level of interaction and engagement with all the main stakeholders. MINDEF has a strong engagement with the MAF while only a satisfactory level of engagement with MDI and NDUM. The research identified three key challenges for government engagement: prioritising a continuous commitment to defence R&D funding, a lack of integrated communication, and a lack of a clear process and platform to engage with other stakeholders.

Overall, the interviews and analysis reflect that despite the steady relationship on defence R&D at multiple platforms, the interaction between MINDEF and MAF is usually ad-hoc and intermittent (Interviewee GOVT1). The lack of communication between the government and end-user community is reflected in a lack of strategic planning and focus which leads to a lack of effective outcomes for defence R&D projects (MINDEFb 2021; MINDEFc 2021; MINDEFb 2019; Defence Industry Division 2020). In addition, while MINDEF has had a constructive relationship with the industry top-level management, there is still a gap at the implementation stage (Interviewee GOVT1 2020).

Government can also struggle with receiving sufficient and informative feedback from research units within MDI firms on the success and outcome of the projects (Interviewee GOVT1 2020). Similarly, interviews also mention a lack of discussion on how the government could be a valuable collaboration conduit between industry and academia to ensure effective commercialisation (Interviewee AC2 2020; Interviewee IND1 2020; Interviewee IND2 2020; Interviewee EU1 2019; Interviewee EU2 2019).

STRIDE is an important component of the government’s R&D eco-system. In the context of STRIDE’s engagement with other stakeholders, STRIDE highlighted a lack of expertise and adequate funding for R&D, which had, among others, led to low product commercialisation, highlighting these factors as the general challenges that need to be continuously managed by the research agency (Wan Hanafi 2021; Interviewee GOVT2 2020). STRIDE indicated a strong relationship with MINDEF; satisfactory relations with the end-users; good relations with the industry; and weak relations with academia. STRIDE is continuously engaged with MINDEF through continued discussions on various issues at different platform levels (Interviewee GOVT2 2020). In relation to the end-user, STRIDE stated that test and evaluation of products developed by industry are occasionally accepted by end-users without much engagement or consultation from STRIDE (Interviewee GOVT2 2020).

STRIDE also mentioned that it has had some level of engagement with academic institutions in the past, mainly collaboration in several small-scale projects with universities, particularly NDUM in supporting postgraduate students with research facilities and guidance (Interviewee GOVT2 2020). However, this type of ‘ad-hoc’ and inconsistent engagement is neither sufficient nor constructive. Research organisations like STRIDE need to find ways to collectively engage and make available the best pool of capable resources for industry needs (Interviewee GOVT2 2020). Other issues often raised within STRIDE include the extensive workload involved in supporting government staff requirements (GSRs), certification exercises for the MAF, and being overloaded with administrative paperwork, leaving researchers little time for pure research activities (Interviewee GOVT1 2020; Interviewee GOVT2 2020; Interviewee EU1 2019; Interviewee EU2 2019).

End-users (MAF)
The MAF described a steady level of engagement with MINDEF and STRIDE. However, the level of engagement with industry is modest while engagement with academia is weak. Despite a good relationship with STRIDE, the MAF interviewee still expressed concern over the lack of quality communication which prevented a more effective relationship (Interviewee Interviewee EU2 2019, EU2). Often, the poor communication channel has left the planned projects impaired and
incomplete, or with products that do not meet the needs of the end-users (Mohamad Nor 2021; Interviewee EU1 2019). This lack of effective communication has also led to a mismatch between end-users and suppliers of defence R&D products and services, which remains a huge challenge for stakeholders. Often a challenge arises when the end-users themselves are unsure of the specification or lack the expertise internally to test, evaluate and provide objective feedback to the suppliers (Interviewee EU1 2019; Interviewee EU2 2019).

Overall, the engagement between end-users and industry has not been constructive in the Malaysian defence sector. There is still a lack of confidence and trust on the R&D capabilities of local companies (Wan Hanafi 2021; Interviewee EU2 2019). Interviewee EU2 described ‘not enough engagement between the end-user and industry. Users shy away from the industry players and view them as liabilities, but OEMs as an opportunity.’ When seeking views on engagement with academia, the end-user was of the view that the relationship exists but with ‘quite isolated engagement’. Suggestions put forward by the end-user include the need to create a MINDEF-specific platform for defence R&D to provide guidance on stakeholders’ relations and engagement, adding that ‘there is no specific guidance to facilitate communication and enhance the relationship between the end-user with the industry and academic communities in the R&D space’ (Interviewee EU1 2019).

**Academia (NDUM)**

For NDUM, interview findings indicated a weak level of engagement with MINDEF, STRIDE, as well as end-users, but a sufficient relationship does exist with industry (Interviewee AC1 2021; Interviewee AC2 2020). The lack of budgetary allocation for R&D projects was the major issue highlighted by interviewees stating: ‘the need to allocate more funds with easier approval for defence-related projects’ (Interviewee AC1 2021; Interviewee GOVT2 2020). The issue is closely related to the limited independence of NDUM to plan its technology roadmap and R&D strategy, as the university’s budget is subject to the approval of the Economic Planning Unit (EPU). This limits planning for long-term R&D projects as ‘EPU determines which projects get approved. Therefore, it is difficult to plan for long term R&D projects with uncertainty over continuity’ (Interviewee AC1 2021). In this context, weak engagement with MINDEF and other government agencies further leads to a lack of independence in determining R&D project focus and direction.

NDUM also has a considerably weak strategic engagement with STRIDE. NDUM researchers lack the opportunity and exposure for attachment or placement with STRIDE on collaborative projects. Further, there has been a lack of strategic guidance and engagement for discussions on future planning for defence R&D focus between NDUM and STRIDE (Interviewee AC1 2021; Interviewee AC2 2020; Interviewee EU1 2019; Singh 2019). Findings also reveal the lack of a robust relationship between NDUM and the MAF (Interviewee AC1 2021; Interviewee AC2 2021; Interviewee GOVT2 2020; Interviewee EU1 2020). NDUM must promote greater engagement in providing scientific and technical advice and collaborative R&D projects with the MAF. However, the MAF has not fully been able to engage with NDUM due to the limited capabilities of the university itself. NDUM has suffered from challenges with insufficient infrastructure, especially specialised hardware, as well as finding academics in the required specialised research fields (Interviewee AC1 2021; Interviewee AC2 2020; Interviewee EU1 2019; Singh 2019).

NDUM does however have a stronger relationship with the MDI. However, challenges again present themselves regarding the industry’s lack of trust and confidence in NDUM’s R&D capabilities for real-world application. A globally acknowledged challenge in this field is in crossing the ‘valley of death’ by moving away from pure research to real-world application, and it has been equally challenging for NDUM to collaborate with industry to translate pure research into application and commercialisation (Interviewee AC1 2021; Interviewee EU1 2019). Overall, stakeholder engagement between NDUM and MINDEF, STRIDE, MAF and the MDI has been challenging, exacerbated by a significant lack of communication (Interviewee IND2 2020; Interviewee EU1 2019). The interview
results also suggest a persistent lack of trust in research capabilities within NDUM. Further, NDUM has also not fully realised the potential to tap into and collaborate with the available pool of researchers within other Malaysian universities.

Industry (The MDI)

The MDI has been vocal about an unsatisfactory level of engagement with government and the MAF. Further, they report even less engagement with research institutes and academia (Interviewee IND1 2020; Interviewee IND2 2020). The industry interviewees lamented the lack of strategic direction and guidelines from the government regarding defence R&D prioritisation according to each sectors' needs (Interviewee IND1 Interviewee IND2 2020). The industry players’ argument resonates with STRIDE and the MAF's views in relation to the need for the government to step up their policy focus and provide clear guidelines or action plans for defence R&D implementation (Interviewee IND1 2020; Interviewee IND2 2020; Interviewee GOVT2 2020; Interviewee EU1 2019). Similarly, Interviewee IND2 mentioned that ‘there are sufficient engagement platforms between the industry and end-users. However, these platforms have been less successful due to the lack of understanding within local companies to translate military issues and R&D requirement into innovative solutions’ (Interviewee IND2 2020). The issue could also be related to the lack of confidence from end-users towards the local industry regarding their research and innovative capabilities when compared to OEMs (Interviewee EU1 2019; Interviewee EU2 2019). Some responsibility could fall to the industry itself for being unable to demonstrate and communicate its capability, and an inability to demonstrate sufficiently successful outcomes from R&D activities (Interviewee IND2 2020).

Despite the holistic representation of the various key stakeholders in MIDES, it is claimed that there is a lack of interaction and agreement between them on how to handle issues related to R&D activities (Interviewee GOVT1 2020; Interviewee IND2 2020; Interviewee AC2 2020; Defence Industry Division 2020; Interviewee EU1 2019; Interviewee EU2 2019). The topic is shunned as most industry members see themselves as competitors rather than collaborators due to a lack of collaborative R&D projects initiated by MINDEF or the MAF (Interviewee GOVT1 2020; Interviewee IND2 2020; Interviewee EU1 2019; Interviewee EU2 2019).

Conclusion and Recommendations

Conclusion

This paper discussed the role of the key stakeholders – government, end-users, industry and academia – in managing defence R&D funding. In the context of this paper, we defined the role of the government as being responsible for setting out the defence R&D strategy, developing the R&D roadmap, allocating sufficient funding, and supporting and coordinating R&D implementation. STRIDE, which is the strong defence research arm of the government is responsible for supporting the defence R&D strategy and implementation through scientific and technical advice, The end-users (MAF) are responsible in ensuring that local MDI capabilities and involvement is considered when planning the acquisition of defence equipment and support. The MDI is responsible for industrial development, economic growth and productivity through product and process innovation. While the academic sector is responsible for developing the required research skills that can feed into defence R&D and related sectors.

The paper specifically identified three key challenges resulting from a lack of stakeholder engagement that has hindered defence industrial innovation in Malaysia. The first of these challenges is the lack of strategic intent between stakeholders to develop a comprehensive defence R&D strategy with a plan and technology roadmap. Another challenge is presented by the inability to
create a common platform and process for effective communication in delivering R&D projects, while the final challenge lies in the inability to consolidate existing R&D skilled personnel, resulting in an inefficient use of skilled resources.

Based on our research analysis and findings, we also conclude that the level of defence R&D collaboration between stakeholders is low in the context of the Malaysian environment. This leads to a modest level of defence innovation success in Malaysia, despite continuous R&D investment. The results appear contrary to recommendations offered by literature which specify collaboration as a key source of competitive advantage for companies to enhance their R&D capabilities, especially when resources and inputs are scarce and need to be shared or obtained from external sources, as in the Malaysian defence environment (Carayannis and Campbell 2009; Etzkowitz and Leydesdorff 1995; Hamel and Prahalad 1989). Therefore, it is important to emphasise collaboration that involves access to outside resources, based on the idea that resources and expertise do not exist solely within an organisation but also outside an organisation becomes important (Freeman et al. 2015).

As demonstrated in this paper, there has unfortunately been limited sharing of resources between stakeholders in the Malaysian defence R&D environment, resulting in the inability to leverage available external resources for a more effective R&D outcome. Research evidence also suggests that the MDI stakeholders work in a silo and undertake incremental R&D activities within their organisations without significant external involvement, reflecting the weak level of engagement between stakeholders. Hence, the interviewed stakeholders reported that better collaboration, communication, and engagements could resolve the issues of weak defence R&D outcomes in the MDI sector.

**Recommendations**

Based on the fieldwork, research findings, and analysis, we propose several policy suggestions regarding defence R&D investment and allocation to best promote industrial innovation. The evidence suggests that defence R&D stakeholders are currently disconnected, lack communication platforms, and operate in a silo. However, it was hard to obtain sufficient data that covered all aspects of the issues considering the limited resources that were available to the researchers. Hence, there are future opportunities to undertake further research in the field of Malaysian defence R&D, mainly on evaluating the impact of defence R&D spending on industrial innovation. This research has also not focused on the contribution of defence R&D to dual-use technology development.

In this regard, we make the following suggestions.

**Independent Platform and Innovation Networks**

We suggest that the government initiates an independent and specific platform that could bring all the different stakeholders together with the primary objective of developing a comprehensive national defence R&D strategy and implementation pathway. This is in line with an interviewee suggestion for the creation of a specific body to handle defence R&D for the MDI (Interviewee GOVT1 2020). In the past, such platforms were set up outside the realm of defence for collaborative R&D&C, including the SIRIM-Fraunhofer partnership, AIM-Steinbeis Foundation Malaysia and SME Corp-PlaTCOM. Despite several quick wins resulting from these platforms, they have subsequently struggled to scale up (Economic Planning Unit 2010). The defence sector should take lessons from the difficulties that some commercial R&D platforms have had and develop clear terms of reference for how this platform should operate by detailing each stakeholder’s responsibility to encourage collaboration.

At the same time, if a country like Malaysia wants to lead on innovation, we recommend a greater level of discussion related to R&D and innovation to be held as part of policy forums, at select parliamentary committees, and at other such meetings. We suggest that an industry-academia translation committee be set up to formulate policy briefs relating to successful case studies and impact analyses from R&D projects.
**Cross-fertilisation Programme**

There is also clear evidence of the lack of motivation from both the academic and industry sectors to invest in R&D. Often, the government is looked upon as the sole source of investment. We would like to suggest that the academic and industry sector continue cross-fertilisation programmes through the exchange of researchers, placements, attachments, internships and investment into jointly funded projects and joint patent production through matching grants. There were many such initiatives in the past, but the flow of researchers from academia and research think-tanks into the industry has been more significant than industry researcher secondment into academic institutions. There was a strong desire from the interviews for cross-fertilisation between the MAF and industry, where military officers could be attached as consultants to defence companies, with the reasoning that the military knows end-user expectations and requirements (Interviewee IND2 2020). Cross-fertilisation is necessary to build networks, understand different organisational cultures, and build relationships between stakeholders. If the MAF and academic institutions want to help solve industry problems and enhance their capabilities, it is crucial that they trust and build a solid collaborative research culture with the MDI. Further, cross-fertilisation, attachment, internships and placements should also be encouraged with joint venture companies and OEMs based on mutual interest and trust. R&D projects leading to successful commercialisation have better chances of success if there is a strong buy-in from the industry and more industry placement in universities. Similarly, if the MDI want to build their own internal industry research capabilities for innovation, they should invest in sponsoring PhDs or Engineering Doctorates as well as offering apprenticeship programmes to students.

**Re-alignment of University Technology Transfer Offices (Ttos)**

There needs to be a stronger academic will to progress from fundamental research to applied research. Academic engagement with the defence industry and community at the higher end of the technology spectrum is vital, encouraging a demand-driven defence research environment to best identify and provide solutions to real-world problems. Then there are challenges regarding legal frameworks in how universities and external parties share IPR ownership. These are issues pertaining to ownership of the IPR, the level of profit-sharing, and how the technology is exploited for commercialisation. We suggest that universities realign their TTOs around IPR issues. A successful model is the Cambridge model, where the researcher is allowed to own their IPR. TTO offices should encourage IPR models that are flexible and reward-based to encourage defence innovation.

**Defence R&D Data Analytics Management Centre**

Finally, an independent Defence R&D data centre that captures defence R&D data such as activities and projects for access by authorised stakeholders may be useful to evaluate the status of the R&D projects. A centralised data system should capture specified objectives of defence R&D such as patent production, research papers, and product, process and business innovation. The Data Centre can make available data to researchers from the industry and academia for better innovation output. This is also a step forward in creating value and ensuring greater transparency in the collaborative defence R&D engagement. The data centre will help MINDEF measure policy performance, R&D focus areas and stakeholder performance. MINDEF could also use the system to evaluate successes and identify challenges to help improve future defence R&D policy and implementation.

We believe that the above suggestions may enhance the current fragmented defence R&D stakeholder environment. The recommendations have been put forward based on evidence from our empirical research and other critical government reports and papers. We also suggest the DRD5E5 model could be applied to other nations in their defence R&D stakeholder engagement analysis. Nevertheless, the model is not perfect and must be tweaked to fit local contexts on a case-by-case basis.
Notes

1. Figures on defence R&D prior to 2001 was not available as it was only published from the 8th MP.
2. R&D projects that are being undertaken in NDUM are related to such topics as: Blast & Ballistic; Vehicle and Mobility Systems; Rocket, Radar, Aviation & Tracking System; ChemDef & Tropicalisation; Disaster Relief; Advanced Material (Mohamad Nor 2021).
3. This focus can be seen from the faculties, academic centres and Centre of Excellence in the University that are highly focused on defence including Centre for Defence Foundation, Faculty of Defence Science and Technology, Faculty of Medicine and Defence Health, and Academy of Defence Fitness. Meanwhile, the COEs includes the Centre for Defence Research and Technology; Centre for Cyber Security & Digital Industrial Revolution; Centre for Tropicalization; Centre for Humanitarian and Disaster Relief; Regional Centre for Military Law and International Humanitarian Law; Maritime Research and Excellence Centre among others (Mohamad Nor 2021).
4. The Valley of Death phenomenon relates to the difficulty in implementing, accelerating, or commercialising an innovation project (Sandberg and Aarikka-Stenroos 2014). In technology transfer, the ‘valley of death’ describes the gap between academic-based innovations and their commercial application in the marketplace. Although traditional definitions of technology transfer often assume a smooth shift of intellectual property from university (or private) research laboratories to companies that commercially develop the technology, the valley of death suggests that the practice is anything but smooth (Gulbrandsen 2009).

Disclosure Statement

No potential conflict of interest was reported by the author(s).

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References


Interview ATSC. 2019. Interview with ATSC official. In discussion with author. 6 September

Interview with AC2. 2021. Interview with AC2. In discussion with Author. 2 July

Interview EU1. 2020. Interview with End-User. Interview EU1. 14 July


Interviewee AC2. 2020. “Interview with Academia 2. Email Correspondence to the Author.” 14 July 2020.

Interviewee ADS. 2021. “Interview with ADS Official.” In discussion with author. 1 July 2021

Interviewee Defence Industry Division. (2021),“Interview with Defence Industry Division Official.” In discussion with author. 2 June 2021


Interviewee IND1. 2020. “Interview with Industry 1.” In discussion with author, 20 June 2020


Interviewee OpenApps. 2021. “Interview with OpenApps.” In discussion with author. 2 July 2021


Interview STRIDE 2021. Interview with STRIDE official. In discussion with author. 14 April


Wan Hanafi, W. M. 30 July 2021. “Institut Penyelidikan Sains Dan Teknologi Pertahanan – Science and Technology Research Institute for Defence (STRIDE)”. Presentation slide, RTKP Sharing Session, Ministry of Defence, Malaysia

