Understanding the Ministry of Defence’s Wider Contribution to UK Prosperity

Measuring Defence Output

Luke Huxtable, Kate Cox, James Black, Keith Hartley, Ron Smith, Matthew Uttley, Benedict Wilkinson, Charlene Rohr, Hui Lu
RAND Europe conducted the research contained in this report for the Analysis Support Construct, a framework led by BAE Systems CORDA to service the demand for analysis required by government decision-makers across UK Defence and Security.

For more information on this publication, visit www.rand.org/t/RRA638-1

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Preface

This report presents the findings of a study that was commissioned by the UK Ministry of Defence (MOD)’s Defence Science and Technology Laboratory (Dstl) to examine different approaches to assessing UK Defence’s contribution to national prosperity. The analysis it contains seeks to inform a better understanding of different methodologies that could help the MOD to quantify the value that defence brings to the nation (e.g. in terms of security, influence and prosperity).

The report represents the final output of research by RAND Europe on behalf of the Analytical Support Construct, a framework led by BAE Systems CORDA to service the demand for analysis required by government decision-makers across UK Defence and Security.

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Summary

Introduction

Despite the growing policy emphasis on understanding the value of UK defence\(^1\), assessing the primary benefits\(^2\) of defence remains a challenge. Defence is inherently complex, and it remains difficult to prove that the non-occurrence of an event (e.g. a conflict) is directly related to the existence of defence capabilities and activities. Linked to these challenges, connecting defence activity and output to defence outcomes and benefits remains elusive.

This study has explored the potential of five methodologies (lines of enquiry – LOEs) to measure the contribution of defence to UK prosperity in terms of its primary benefits (i.e. protection from external threats). These are:

- **LOE1** – defence analogue to Quality Adjusted Life Years (QALYs)\(^3\);
- **LOE2** – Value of a Statistical Life (VSL) measures;
- **LOE3** – insurance policy techniques;
- **LOE4** – logic models and proxy indicators; and
- **LOE5** – discrete choice experiments (DCEs).

This study has identified a range of insights for the Ministry of Defence (MOD) on how to apply and further develop these methodologies towards measuring the primary benefits of defence. This study has been exploratory, and it was expected that not all approaches would be viable.

It is vital that the MOD considers how the methods investigated in this study can be layered or combined to understand the whole picture of how defence value can be measured. To aid this effort, we have developed a basic assessment framework for improving understanding of the links and dependencies between the LOEs.

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2. The primary benefit of defence is defined as the protection it provides from external threats and aggression, which allows the economy and society to function peacefully.

3. For the purpose of this study, the suggested defence analogue for QALYs was denoted as Protection Adjusted Life Years (PALYs).
Approach

This study was commissioned by Dstl and delivered by RAND Europe and its academic partners. The study involved two primary phases of activity: firstly, a scoping review and expert engagement to identify and shortlist potential methodologies; and secondly, deep dives into each of the shortlisted LOEs and integration of the findings within an overarching framework. The figure below illustrates the study’s approach.

Findings

Based on the research into the five individual LOEs, it is apparent that whilst none offer a comprehensive solution in their own right, PALYs (LOE1), VSL (LOE2), logic models and proxy indicators (LOE4) and DCEs (LOE5) each offer opportunities that could pave the way for an improved understanding of defence’s contribution to prosperity. Insurance techniques (LOE3) cannot measure primary benefits, but could support defence decision-making by helping to conceptualise, manage and ‘price’ defence risks. For each methodology, an assessment of the opportunities, relevance and feasibility of implementation have been assessed.

| LOE1 – Protection Adjusted Life Years (PALYs) |
|-----------------|-------------------------------------------------------------------------------------------------|
| **Opportunities for defence** | Could be used to quantify the benefits of new defence policies, capabilities, tactics, and technologies in terms of protection. |
| **Relevance to defence** | Defence and health contexts vary, requiring a bespoke PALYs methodology to be designed for UK defence. |
| **Feasibility of implementation** | The resource burden for adapting QALYs from the health sector to defence is substantial and would require significant stakeholder involvement. |

| LOE2 – Value of a Statistical Life (VSL) |
|-----------------|-------------------------------------------------------------------------------------------------|
| **Opportunities for defence** | Could be used to quantify (and in some cases potentially monetise) the benefit of different investment options by comparing the risk to life. |
| **Relevance to defence** | Offers some application to defence (through comparing defence capability options), but identifying a monetary value for VSL is challenging. |
| **Feasibility of implementation** | Already used by other UK government departments, but using a VSL approach to gather evidence on the public’s willingness to pay for defence would require time. |
The individual LOE research teams investigated each of these methodologies independently, and demonstrated that there appears to be no single approach that can fully quantify the primary benefits of defence. In light of this, a simple assessment framework was developed to draw together insights from the LOEs to visualise the comparative utility of different approaches and areas that are not covered by them. The figure below illustrates the overarching assessment framework.

<table>
<thead>
<tr>
<th>LOE3 – Insurance policy techniques</th>
<th>Opportunities for defence</th>
<th>Relevance to defence</th>
<th>Feasibility of implementation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Specialised insurance techniques for modelling, managing and pricing risks offer relevance for defence decision-making on risk.</td>
<td>Difficult to place a value on defence as an insurance premium as this relies on counterfactuals and a degree of speculation.</td>
<td>It would not be feasible to use insurance techniques to quantify the primary benefits of defence.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>LOE4 – Logic models and proxy indicators</th>
<th>Opportunities for defence</th>
<th>Relevance to defence</th>
<th>Feasibility of implementation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Useful framework for conceptualising and understanding how defence inputs contribute to its primary benefits.</td>
<td>Already used in defence to evaluate operations, but challenges remain in conceptualising the value of defence capability.</td>
<td>A well-understood approach and feasible to implement; however, developing and collecting proxy indicators could be challenging.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>LOE5 – Discrete Choice Experiments (DCEs)</th>
<th>Opportunities for defence</th>
<th>Relevance to defence</th>
<th>Feasibility of implementation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Offers a foundation for quantifying public perceptions of primary defence benefits and opportunity costs, including willingness to pay.</td>
<td>Holds promise for offering defence a clear indication of the value placed on it by UK citizens.</td>
<td>A feasible approach to understanding public perceptions of defence, but requires a large-scale survey (2,000–5,000 respondents).</td>
</tr>
</tbody>
</table>

The approach does not appear to be capable of assessing or quantifying this aspect of defence

<table>
<thead>
<tr>
<th>Defence inputs</th>
<th>Defence activities</th>
<th>Defence outputs</th>
<th>Defence outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>PALS</td>
<td></td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>VSL</td>
<td></td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Insurance Techniques</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Logic model &amp; indicators</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>DCEs</td>
<td></td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

This framework demonstrates that the five LOEs provide a reasonable coverage of the problem space and offer possibilities for defence to improve its understanding and quantification of its contribution to national prosperity.
Recommendations

The MOD should consider taking forward the research from this study in the following ways:

- Develop an improved understanding of how defence contributes to national prosperity, by further developing and refining the defence logic model (LOE4).

- Improve the understanding and quantification of public perceptions of defence, its benefits and opportunity costs through the use of a DCE (LOE5).

- Consider the development of new approaches to quantify (and possibly monetise) the benefits of defence, especially through PALYs (LOE1) and VSL (LOE2).

- Employ proxy concepts for assessing the benefits of defence where actual measures of benefit cannot be identified or developed (see specific suggestions under LOE4).

- Engage with insurance industries to identify which techniques might help to improve the MOD’s management, modelling and pricing of defence risk.

- Apply each assessment framework to a particular area, such as a specific mission-type, to test the application of multiple methods to a specific question of quantifying primary benefits of defence.
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<table>
<thead>
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<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASC</td>
<td>Analysis Support Construct</td>
</tr>
<tr>
<td>CNI</td>
<td>Critical National Infrastructure</td>
</tr>
<tr>
<td>COEIA</td>
<td>Combined Operational Effectiveness and Investment Appraisal</td>
</tr>
<tr>
<td>COVID-19</td>
<td>Coronavirus Disease 2019</td>
</tr>
<tr>
<td>COIN</td>
<td>Counterinsurgency</td>
</tr>
<tr>
<td>CT</td>
<td>Counterterrorism</td>
</tr>
<tr>
<td>CV</td>
<td>Contingent Valuation</td>
</tr>
<tr>
<td>CVM</td>
<td>Contingent Valuation Methods</td>
</tr>
<tr>
<td>DCDC</td>
<td>Development, Concepts and Doctrine Centre</td>
</tr>
<tr>
<td>DCEs</td>
<td>Discrete Choice Experiments</td>
</tr>
<tr>
<td>DIME</td>
<td>Diplomacy, Information, Military, Economic</td>
</tr>
<tr>
<td>Dstl</td>
<td>Defence Science and Technology Laboratory</td>
</tr>
<tr>
<td>DVP</td>
<td>Defence Value Proposition</td>
</tr>
<tr>
<td>GDP</td>
<td>Gross Domestic Product</td>
</tr>
<tr>
<td>GSP</td>
<td>Global Strategic Partnership</td>
</tr>
<tr>
<td>HM</td>
<td>Her Majesty’s</td>
</tr>
<tr>
<td>IP</td>
<td>Intellectual Property</td>
</tr>
<tr>
<td>LOE</td>
<td>Line of Enquiry</td>
</tr>
<tr>
<td>MACA</td>
<td>Military Aid to the Civil Authorities</td>
</tr>
<tr>
<td>MOD</td>
<td>Ministry of Defence</td>
</tr>
<tr>
<td>NCSS</td>
<td>National Cyber Security Strategies</td>
</tr>
<tr>
<td>NDRI</td>
<td>National Defense Research Institute</td>
</tr>
<tr>
<td>NHS</td>
<td>National Health Service</td>
</tr>
<tr>
<td>NSO</td>
<td>National Security Objectives</td>
</tr>
<tr>
<td>NZDF</td>
<td>New Zealand Defence Force</td>
</tr>
<tr>
<td>OGD</td>
<td>Other government department</td>
</tr>
<tr>
<td>PALYs</td>
<td>Protection Adjusted Life Years</td>
</tr>
<tr>
<td>PESTLE</td>
<td>Political, Economic, Social, Technological, Legal, Environmental</td>
</tr>
<tr>
<td>QALYs</td>
<td>Quality Adjusted Life Years</td>
</tr>
<tr>
<td>R&amp;D</td>
<td>Research &amp; Development</td>
</tr>
<tr>
<td>RP</td>
<td>Revealed Preference</td>
</tr>
<tr>
<td>SALYs</td>
<td>Security Adjusted Life Years</td>
</tr>
<tr>
<td>SP</td>
<td>Stated Preference</td>
</tr>
<tr>
<td>-----</td>
<td>----------------------------</td>
</tr>
<tr>
<td>UK</td>
<td>United Kingdom</td>
</tr>
<tr>
<td>UKCeMGA</td>
<td>UK Centre for the Measurement of Government Activity</td>
</tr>
<tr>
<td>VfM</td>
<td>Value for Money</td>
</tr>
<tr>
<td>VSL</td>
<td>Value of a Statistical Life</td>
</tr>
</tbody>
</table>
In conducting this study, the team is grateful to the many people who provided their time, advice and support. The authors would first like to thank the Dstl team – particularly Sean Monaghan, Rory Heard and Tony Quinn – for their sponsorship of this study.

We are indebted to the Analytical Support Construct (ASC) Programme Management Office at BAE Systems CORDA, who helped to ensure the project ran smoothly and effectively throughout. A special acknowledgement goes to Robert Bristow, who provided technical guidance and assurance in his role as ASC Technical Lead, and without whom this report would not be the product it is.

We would like to thank the government, industry and academic representatives who contributed to all of the workshops and interviews.

Finally, we are indebted to our RAND Europe reviewers Hans Pung and Lucia Retter for their thoughtful comments and suggestions, which have greatly improved the final document.
1. Introduction

In October 2019, the Defence Science and Technology Laboratory (Dstl) commissioned RAND Europe and leading UK academics through the Analysis Support Construct (ASC) to deliver a study to understand the MOD’s wider contribution to the UK’s national prosperity. This study has focused on the primary benefit of UK defence, defined as the UK’s ability to provide security and protection from external threats, therefore enabling the UK’s economy and society to prosper. This project was highly experimental in nature, as endorsed by Dstl and the ASC Technical Lead at initiation. The analysis was undertaken with recognition that the explored methodologies might not be applicable in the defence context, which itself would represent a step forward in defence’s understanding of how to measure its primary benefits. The research has focused on assessing the feasibility of the selected approaches and advancing collective understanding of how they might be applied, rather than seeking to assign a clear value to the primary benefits of defence – whether qualitative or quantitative.

This document includes a summary of the research conducted by various partners and collaborators along the five supporting Lines of Enquiry (LOEs):

- **LOE1** – Defence Analogue to QALYs (Prof. Keith Hartley, Dr Benedict Wilkinson);
- **LOE2** – Value of a Statistical Life Approaches (Prof. Matthew Uttley, Dr Benedict Wilkinson – King’s College London);
- **LOE3** – Insurance Policy Techniques (Prof. Ron Smith);
- **LOE4** – Logic Models and Proxy Indicators (Luke Huxtable, Kate Cox – RAND Europe; Prof. Matthew Uttley, Dr Benedict Wilkinson – KCL); and
- **LOE5** – Discrete Choice Experiments (Charlene Rohr, Hui Lu – RAND Europe).

1.1. Background

Recent years have seen growing emphasis on the importance of understanding and measuring the contribution of UK defence to national prosperity. This theme has been prominent, for example, in the latest Strategic Defence and Security Review (2015), the Dunne Review (2018), and the UK Combat Air Strategy (2018), which outlined conceptual elements of prosperity assessment through the new National Value Framework. More broadly, HM Government seeks to ensure value for money (VfM) in all public

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expenditure, as well as informed and effective spending decisions in line with the HM Treasury Green Book and other guidance, such as the Public Value Framework (2019).  

The measurement of defence’s contribution to national prosperity is a multi-faceted and complex endeavour. The UK MOD has historically not quantified the primary benefits of defence or contribution to prosperity in the same manner or to the same degree as other government departments, due to conceptual, methodological and practical barriers to the generation of robust estimates or analysis in the UK defence context.

The focus on defence’s contribution to national prosperity reflects both the less extensive academic literature that exists, and policy debates on the primary benefits of defence. In contrast, the secondary benefits of defence, which represent the direct and immediately tangible spill over benefits for the civilian economy, (e.g. innovation, or the impact on knowledge) are better understood, and are considered easier to quantify, though still challenging to do in practice. This focus also reflects a common misunderstanding of ‘prosperity’ in narrow monetary terms, when in fact HM Treasury’s Green Book (2020) defines ‘prosperity’ as broader ‘social value’ that encompasses ‘all significant costs and benefits that affect the welfare and wellbeing of the population, not just market effects. For example, environmental, cultural, health, social care, justice and security effects.’

1.2. Purpose and scope

The primary purpose of this exploratory study was to improve the MOD’s ability to measure and articulate UK defence’s contribution to national prosperity. It aimed to achieve this by identifying, assessing, exploring and – where possible – demonstrating a series of potential methodological approaches that could improve how the MOD quantifies the primary benefit of defence (i.e. protection from external threats to enable the UK’s economy and society to prosper).

The study was delivered in two distinct but related phases. Phase 1 ‘Exploration’ (October 2019 to April 2020) focused on bounding the research problem and identifying and shortlisting potential candidate methods (‘Lines of Enquiry [LOEs]’) for quantifying the primary benefits of defence. Phase 2 ‘Proofs of Concept’ (April 2020 to October 2020) undertook an in-depth exploration of five shortlisted LOEs under the leadership of the respective LOE Responsible Owners and the overall management, quality assurance and guidance of RAND Europe and the ASC Technical Lead.

In support of the study objectives, this report addresses six research questions:

Phase 1:

- **RQ1.** What different methodologies could be used for measuring or estimating the primary economic benefits of defence?

- **RQ2.** Which methods are most appropriate (i.e. relevant, feasible) and should therefore be investigated as a matter of priority?

---

5 HM Treasury (2019).

6 HM Treasury (2020).
Phase 2:

- **RQ3.** How transferrable is each of the methodologies to the defence context?
- **RQ4.** What are the barriers to, and opportunities of, applying each approach in the defence context?
- **RQ5.** What could a defence-related equivalent of each approach entail, and how would this methodology work in practice?
- **RQ6.** What are the possible applications of each approach for defence decision-making, and what areas for further research or refinement can be identified?

This activity built upon and is coherent with research conducted by the Global Strategic Partnership (GSP) in 2020, on behalf of the Development, Concepts and Doctrine Centre (DCDC). The purpose of that research was to map out in qualitative terms the ‘value proposition’ of UK defence.⁷

1.3. Research approach

The overarching approach to this study is presented in Figure 1-1 below.

**Figure 1-1 Research tasks, methods and outputs**

Phase 1 of this study focused on scoping the issue of assessing the primary benefits of defence and identifying a shortlist of LOEs for further investigation. This phase was based on a literature review of existing and potential approaches, including techniques applied in other nations or sectors (e.g. health, transport); engagement with leading academics⁸; and an expert workshop held in January 2020 to discuss and down-select the most promising LOEs for Phase 2.

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⁷ Black et al. (2020).
⁸ Namely Professor Derek Braddon; Professor Keith Hartley; Professor David Kirkpatrick; Professor Ron Matthews; Professor Ron Smith; Professor Matthew Uttley; and Dr Ben Wilkinson.
Phase 2 involved an in-depth exploration of the five shortlisted LOEs, after which the findings of each LOE were incorporated into an overarching assessment framework in order to articulate how different methods might be applied to assess different aspects of defence. A short description of each LOE from Phase 2 is presented in Box 1 below.9

**Box 1 Lines of Enquiry (LOEs)**

<table>
<thead>
<tr>
<th>LOE1: Defence analogue to Quality Adjusted Life Years (QALYs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>This LOE investigated the development of a defence-related equivalent to QALYs, which are routinely used in the health and social-care sector to measure the length and quality of life.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>LOE2: Value of a Statistical Life (VSL) methodologies</th>
</tr>
</thead>
<tbody>
<tr>
<td>This LOE explored the applicability of methods for assessing the value of preventing fatalities in the UK defence context. Commonly referred to as the ‘Value of a Statistical Life’ (VSL) approach, this methodology indicates the amount that individuals are willing to pay to reduce the risk of death.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>LOE3: Insurance policy techniques</th>
</tr>
</thead>
<tbody>
<tr>
<td>This LOE investigated whether insurance techniques for measuring, modelling and managing risk can be applied within a defence context. Insurance is used in the financial sector to protect individuals, businesses and societies from financial loss.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>LOE4: Proxy indicators for the impact of defence outputs on outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOE4 assessed whether logic models can be used to conceptualise defence inputs, activities, outputs and outcomes, and if proxy indicators can be used to assess the contribution of defence outputs to prosperity-related outcomes.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>LOE5: Application of discrete choice experiments (DCEs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discrete choice experiments (DCEs) provide an analytical framework for examining drivers of individuals’ choices in relation to non-market goods and services. LOE5 involved exploring whether DCEs could help the MOD understand public willingness to pay for defence, and to assess the value placed on defence outputs/activities.</td>
</tr>
</tbody>
</table>

Each LOE was undertaken as a mini research project and drew on a combination of data gathering and analytical activities. From this the lead researchers produced an analytical summary of the findings in the form of five LOE Summary Papers, which were shared internally amongst the project team and stakeholder community. Research activities underpinning each LOE included:

- Targeted review of academic and grey literature;
- Stakeholder consultation with key informants;
- Piloting of some LOE methodologies; and
- A synthesis workshop.

An internal workshop was also held to develop the overarching framework in order to articulate how different methods might be applied to assess different aspects of defence, and quantify its primary benefits.

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9 Chapters 2–3 respectively outline the process of shortlisting the LOEs and describe each LOE in more detail.
2. Identification of candidate methods

This chapter provides an overview of findings from Phase 1. This section addresses the first two research questions set out in Chapter 1.

<table>
<thead>
<tr>
<th>Phase 1 research questions:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>RQ1</strong>. What different methodologies could be used for measuring or estimating the primary economic benefits of defence?</td>
</tr>
<tr>
<td><strong>RQ2</strong>. Which methods are most appropriate (i.e. relevant, feasible) and should therefore be investigated as a matter of priority?</td>
</tr>
</tbody>
</table>

2.1. What methodologies could be used for measuring the primary benefits of defence?

The first task aimed to identify a longlist of potential methods that could be used to measure defence output in terms of its contribution to UK national prosperity. Insights were identified from a review of literature across various fields, including – but not limited to – health, policing, transport and economics/finance. The longlist of potential LOEs is:

- Discrete choice experiments (DCEs);
- Defence analogue to QALYs;
- Econometric measures of returns on defence interventions;
- Empirical measures of cost avoidance;
- Proxy indicators of benefits of defence engagement;
- Logic models and proxy indicators of defence outputs;
- Risk-based analysis of cost-benefit of deterrence;
- Insurance policy techniques; and
- Value of a Statistical Life (VSL) approaches.
The longlisted methods were discussed, refined and down-selected at a workshop held in January 2020. Workshop participants included RAND Europe, Dstl, MOD and academic stakeholders. A structured approach based on the Heilmeier Catechism\(^\text{10}\) was used to compare the candidate LOEs, based on:

- **Approach**: the objectives of each potential LOE and a way forward for developing the methodological approach.
- **Relevance**: the scope of each potential LOE, whether the method can quantify benefits, its novelty and its exploitability for defence.
- **Feasibility**: the main risks, barriers and enablers to successful execution of the LOE.

During the shortlisting process, Dstl and the ASC team agreed to adopt a portfolio approach that would allow the study team to examine both some of the more obvious LOEs that stakeholders across Whitehall would expect defence to investigate – given the successful and high-profile adoption of certain methods in other sectors – as well as more exploratory studies into LOEs that might further ‘push the envelope’ on what is or is not possible for quantifying the primary benefits of defence.

### 2.2. What methods should be investigated further?

Following the workshop, five shortlisted LOEs were selected for Phase 2. Table 2-1 summarises each LOE and the rationale for their selection.

<table>
<thead>
<tr>
<th>LOE</th>
<th>Rationale for selection</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOE1 Defence analogue to QALYs</td>
<td>Included given its successful application in the health sector and its prominent place in cross-Whitehall and academic debates.</td>
</tr>
<tr>
<td>LOE2 Value of a Standard Life approaches</td>
<td>Included due to its successful application outside of defence and the merit of using an existing approach within a defence context.</td>
</tr>
<tr>
<td>LOE3 Insurance policy techniques</td>
<td>A sizeable insurance industry and toolkit of techniques exists for monetising risk. There is also a common analogue drawn in cross-Whitehall and public debates to the idea of defence as an insurance policy.</td>
</tr>
<tr>
<td>LOE4 Logic models and proxy indicators of defence output</td>
<td>Many of the difficulties in quantifying the defence contribution to prosperity stem from the lack of a clear understanding of the links between defence outputs and outcomes. This LOE explores how qualitative mapping offers a basis for improved understanding of this important issue.</td>
</tr>
<tr>
<td>LOE5 Discrete Choice Experiments</td>
<td>It is important to understand what the UK public ascribe value to. Defence lacks an understanding of the extent to which the public values the benefits of defence. DCEs are a proven technique for addressing this shortfall and have been successfully applied in other sectors.</td>
</tr>
</tbody>
</table>

\(^{10}\) George Heilmeier designed a set of questions to help DARPA officials assess proposed research programmes (DARPA, n.d.).
Several of the candidate LOEs were not included in the shortlist, based on the assessments made at the expert workshop of January 2020. Each of the shortlisted methods presented in Table 2-1 is explored in Chapter 3 to examine how they can support an assessment of different aspects of defence's primary benefits.
3. Deep dive into potential approaches

This chapter presents the key findings of the deep dives that investigated Research Questions 3–6, in each of the five LOEs.

### Phase 2 research questions:

**RQ3.** How transferrable is each of the methodologies to the defence context?

**RQ4.** What are the barriers to, and opportunities of, applying each approach in the defence context?

**RQ5.** What could a defence-related equivalent of each approach entail, and how would this methodology work in practice?

**RQ6.** What are the possible applications of each approach for defence decision-making, and what areas for further research or refinement can be identified?

3.1. Defence analogue to QALYs (LOE1)

3.1.1. Overview of QALYs

The Quality Adjusted Life Year (QALY) is a measure of the value of health outcomes used in the UK and other countries, including the US and Canada. QALYs inform decision-making in the health sector by enabling comparisons between different health conditions and offering a way to explore the effects of new treatments, technologies or medicines. QALYs are used to measure the length and quality of life by taking all health conditions into account and representing them in a single index, based on a cardinal scale. Data is provided by individuals, who indicate their valuations and views about their health state or condition.

In the health sector, the cost-effectiveness of specific interventions is measured by assessing which approaches produce the greatest number of QALYs in relation to cost. On their own, QALYs cannot determine the value for money offered by a new treatment or medicine. Instead, the QALY for a treatment or medicine is combined with its cost. This yields a ratio known as cost per QALY.\(^{11}\) This measurement is regarded as the reference standard in cost-effectiveness analysis in the health sector, with QALYs providing a single measure of effectiveness.

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\(^{11}\) McCabe (2009).
Nonetheless, QALYs present certain challenges. Their measurement is based on a cardinal scale, which is a source of controversy among some health experts. Furthermore, wider aspects of well-being – such as mental health – are not taken into account, and questions have been raised regarding whether QALYs take into consideration all aspects of health benefits. While QALYs are relatively controversial among health economists and experts, they remain the best measurement currently available in the health sector and offer a preferable alternative to relying on ad hoc, arbitrary decisions of individuals.

3.1.2. Transferability to UK defence

In principle, the QALYs methodology appears to be transferable to the defence sector as it offers a promising way of quantifying the primary benefits of defence and measuring the cost-effectiveness of new policies, systems, capabilities and technologies. The QALYs methodology nonetheless raises conceptual problems from the use of cardinal measures, which are limited to applying output measurement to the ‘effectiveness’ part of cost-effectiveness analysis (i.e. QALYs provide a single measure of effectiveness of new medicines, so cost measures are required in addition). Transferring the methodology would also involve significant time and cost, as reflected by the many years and substantial funding that it has taken for health economists and medical experts to develop QALYs for the health sector.

The defence and health contexts differ in a number of ways. Firstly, health services are provided on an ongoing basis, whereas defence activities are largely comprised of preparing for contingent operations. Secondly, the effectiveness of national defence spending can be adversely affected by the defence spending levels of other nations, which is not the case for health spending. For example, a British citizen’s health is affected by UK health spending but not the spending of France, Germany or Italy. Other features that differentiate defence from health include doubts as to whether voters are able to assess external threats to the UK – whereas voters can more accurately assess the state of their health. In light of these sectoral differences, value estimates in the defence context are likely to vary across expert sources. Should the MOD adapt QALYs for UK defence, careful selection of military and civilian panel representatives will be important in helping ensure that the methodology accounts for these differences and reflects the unique features of defence.

3.1.3. Description of a defence-related equivalent

The defence-related equivalent of QALYs is defined as Protection Adjusted Life Years (PALYs) for the purpose of this study, with ‘protection’ referring to protection of the UK from external attacks. The recommended approach to designing and implementing PALYs reflects the QALYs approach and follows three steps: (1) defining states of protection for the UK; (2) selecting panels for assessing defence/protection states; and (3) creating a defence equivalent of EQ-5D (see Step 3 for a description).

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12 The controversy surrounding cardinal scales relates to doubts and disputes about whether utility can be measured on an absolute scale, and whether interpersonal comparisons of utility are feasible and measurable.
13 Mason & Towe (2008).
15 Security Adjusted Life Years (SALYs) offers an alternative.
• **Step 1: Defining states of protection.** This step would involve using a scale from 0 ('defeat') to 1 ('perfect safety'), with further investigation required to identify defence states on this scale. This effort could draw on data on the costs of conflict and on wider economic costs (e.g. inflation, unemployment) that could be adversely affected by conflict. Developing a defence scale also needs to include other aspects of UK defence output, including aspirations to be a world power, and the benefits of humanitarian assistance. This scale would be developed and tested by military and civilian panels.

• **Step 2: Selecting panels.** To develop the scale, a small military panel (composed of up to five people) could be created to explore the features of various states of protection, ranging between 0 and 1. This panel would comprise experts from each of the three services, and a defence economist. To further test and refine the scale created by this panel, a wider military and civilian panel could involve military experts, pacifists, ministers of religion, health professionals, citizens and taxpayers. The proposed panel size is around 3,000 people.

• **Step 3: Creating a defence equivalent of EQ-5D.** In order to compute QALYs for the purposes of healthcare, a questionnaire known as EQ-5D is used to measure generic health states according to five dimensions (mobility, self-care, usual activities, pain/discomfort, anxiety/depression) using a five-point scale.\(^\text{16}\) To assess the practicality and likely cost of constructing PALYs, it is strongly recommended that advice is obtained from the following sources:
  - Health economists in the Department of Health;
  - The EuroQol research foundation in the Netherlands; and
  - University departments and centres for health economics.

3.1.4. **Possible applications and areas for further research**

Following the three steps in Section 3.1.3, the MOD could use PALYs to assess the effectiveness of new defence equipment, military tactics and capabilities – although this will depend on the corresponding threat assessment of the weapon, tactic or force structure being evaluated.\(^\text{17}\) This methodology could produce measures of effectiveness that could be used to rank major defence equipment projects and draw comparative ‘cost per PALY’ estimates for each project, which would provide a ranking that could be compared with the subjective ranking provided by each of the Services. This could be a useful way of comparing the ranking of tanks and aircraft carriers based on the views of military experts and citizens. However, this type of assessment would also have to account for non-traditional threats to defence and security (e.g. threats relating to cyber security, climate change or transnational crime), and consider the complex interplay between different aspects of defence capabilities.

If the MOD was to take forward this LOE, a significant amount of research and investment into this initiative would be required, including the creation of panels to assess the state of external protection for...

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\(^{16}\) Hout et al. (2012); Feng et al. (2014).

\(^{17}\) The UK MOD currently uses a variety of operational analysis to conduct this type of effectiveness assessment.
the UK. As a starting point, it is recommended that the MOD engages directly with health economists in the Department of Health in order to:

- Understand previous experience in designing and implementing QALYs;
- Identify key considerations for adapting the methodology to defence;
- Gain efficiencies in developing an adapted methodology for defence; and
- Ascertain the cost and time implications for developing PALYs through a structured feasibility assessment.

3.2. Value of a Statistical Life methodologies (LOE2)

3.2.1. Overview of Value of Life approaches

The ‘Value of a Statistical Life’ (VSL) approach offers a framework for assigning a value to risk reduction, helping decision-makers identify interventions that could reduce fatalities in a given hypothetical case. In the public sector, VSL is used in cost-benefit analysis to evaluate the efficiency of government policies that are designed to reduce risk. The prominence of mortality risk-reductions as the justification for government policies has meant that VSL has been considered a crucial component of investment appraisal processes in some UK government departments,18 US federal agencies, a range of other countries and intergovernmental agencies. VSL is also used extensively in the private sector – notably the aviation and automotive industries – to underwrite safety cases.

VSL indicates the amount that individuals are willing to pay to reduce the risk of death.19 There are two main methods for calculating VSL: Revealed Preference (RP) and Contingent Valuation (CV). These approaches use choice experiments (see Section 3.5) that allow respondents to make choices between multiple options with different costs and risk reductions.20 However, using these techniques to estimate the VSL has limitations in accurately estimating trade-offs between money and risk. These weaknesses relate to the varying perceptions of risk among individuals; a failure to account for the endogeneity of risk (RP); and hypothetical bias, where respondents provide information for hypothetical scenarios that differs from what would be expected in a real-life situation.

As a result of these limitations, there is considerable variance in calculations of the VSL.21 VSL nonetheless offers a framework for identifying a range of values associated with risk reduction, supporting identification of interventions that could reduce fatalities.

3.2.2. Transferability to UK defence

VSL methods offer potential applications for UK defence. The approach could be used in decision making intended to reduce the risk of death or injury to personnel in the Armed Forces. Through DCEs (see LOE5),

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18 Deloitte (2009).
19 Bosworth et al. (2017).
20 Bosworth et al. (2017).
21 See Social Value UK (2016), for example.
VSL could also shed light on how willing societies are to pay for defence expenditure increases in order to reduce the likelihood of death. However, identifying definitive monetary values is challenging, reflecting the inherent limitations and challenges (as outlined above). These limitations and challenges are particularly significant in attempts to conduct macro-level analysis of the UK population’s willingness to pay to reduce the statistical risk of death through increased expenditure on national defence (as opposed to other public safety improvements in, for example, healthcare).

The research did not identify any examples of countries applying VSL methods to identify a society’s willingness to pay for marginal increases in national defence expenditure. Nevertheless, several VSL approaches with potential transferability for UK defence were identified from the review. For example, cost-benefit analysis has been conducted on increased expenditure on US federal homeland security since 2001 and the estimated number of lives saved due to this increased expenditure. Whilst this general approach is amenable to replication in the case of UK defence, it faces challenges in producing reliable estimates of the expected annual number of lives saved in the UK arising from increased MOD expenditure.

Existing research also addresses the application of VSL in cost-benefit analysis in the UK Department of Transport (DfT), which offers potentially transferrable insights for UK defence. DfT values the prevention of fatalities on Britain’s roads by providing a monetised value of the cost of lives saved. This value is used as a standard for valuing the benefit of measures that preserve human life. If this VSL was to be applied to the MOD, it would provide a stronger analytical basis on which a general approach might be replicated in the UK defence case. Other studies have focused more narrowly on how national armed forces use VSL in safety and force protection decisions. While such studies and existing MOD protocols identify that VSL offers an important tool to evaluate safety and force-protection investments, neither provides insights into the marginal rate of substitution between income (or wealth) and mortality risk that individuals in UK society are willing to pay when it comes to the overall provision of national defence.

3.2.3. Description of a defence-related equivalent

Outlined below are three possible scenarios in which a defence VSL might be feasible as a methodology for quantifying the benefits of defence:

Scenario 1: Capability A vs Capability B

In this scenario, VSL could be used to identify which capability can provide the best value for money in a like-for-like situation. This method is potentially most useful in considering whether to replace or upgrade particular capabilities. The approach is most effective when the capability is specifically designed to protect military lives through – for example – the use of armour and personnel carriers. For more complex weapons

22 It may be that such information does exist, but the resources necessary to conduct a full bibliometric search are beyond the parameters of this exploratory study.
26 See e.g. Kniesner et al. (2015).
systems with other objectives, such as fighter jets or aircraft carriers, this VSL approach appears to be less useful.

**Scenario 2: COEIA vs Do Nothing Option**
In accordance with the MOD’s Combined Operational Effectiveness and Investment Appraisal (COEIA) process, this scenario is useful when a state perceives a threat that it may not possess the capabilities to repel. For example, without missile defence systems, ballistic missiles deployed by enemy states could cause major loss of life. Two features are notable: (1) both situations require modelling (i.e. with and without missile defence); and (2) this is a ‘closed system’ analysis that does not account for other threats or factors in the equation (e.g. second-strike capabilities).

**Scenario 3: All Capabilities vs Less (or More) Capabilities**
This scenario could include building (at least) two models, with one based on the existing capabilities of a nation, and one based on increasing (or reducing) these capabilities by a given percentage. These models could focus on a series of conflict scenarios, with each scenario seeking to understand and quantify the number of lives lost or saved by each intervention. This could help establish whether increased investment is worthwhile. However, the modelling would need to be replicable to ensure consistency across the different capability models. It should be noted that this scenario is the least tightly bound and the most difficult to operationalise of the three scenarios in this Section.

### 3.2.4. Possible applications and areas for further research

VSL offers limited potential to measure the primary benefits of defence. Of the scenarios summarised in Section 3.2.3, Scenarios 1 and 2 offer the most robust uses of VSL that could have meaning and value for policymakers. There is also scope for further research to improve the quality and robustness of modelling approaches. To this end, analysts may wish to consider the possible use of micromorts\(^\text{27}\) to support the modelling of different conflict scenarios, with a focus on the risk of losing a life rather than using the modelling to provide estimates of the lives that might be lost within a given scenario. To take forward Scenarios 1 and/or 2, it is recommended that MOD undertake DCEs (see also LOE5 – Section 3.5), noting the well-documented problems associated with standard RP and CV approaches. DCEs – which present multiple ‘baskets’ of options to a large number of participants\(^\text{28}\) – could offer a robust way of calculating the willingness to pay for fatality risk reduction.

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\(^{27}\) A micromort is a unit that represents the risk of losing a life, with one micromort equal to a 1 in 1 million probability of death related to a specific activity (such as climbing a ladder) or a specific behaviour (such as spending time in a polluted environment) over a given period of time. This information can be used to evaluate the most cost-effective actions for reducing fatality likelihoods.

\(^{28}\) Greene (2009); Mangham et al. (2009).
3.3. Insurance policy techniques (LOE3)

3.3.1. Overview of insurance policy techniques

Insurance is an approach used in the financial sector to protect individuals, businesses and societies from financial loss. In insurance, a decision is made on how much cover to purchase and which uncertain events to insure against. The wider the cover opted for, the higher the premium. In many cases, the insurance premium is based on the value of the asset at stake, for example, a percentage of the value of a house. Insurance companies often use actuarial evidence as a basis for a quantitative assessment of the probabilities of events, such as fires in the case of home insurance. In such cases, insurers can calculate relative frequencies and model possible outcomes. For large, uncommon or complex risks with insufficient data to make relative frequency calculations, insurance companies use risk models calibrated with available data to price insurance and diversify risk.

3.3.2. Transferability to UK defence

Given the unpredictability of threats to the UK, a common analogy is to treat defence policy as an insurance policy. According to this analogy, a ‘premium’ (a defence budget of some percentage of GDP) is invested to account for uncertainty and in such a way that it pays off by reducing damage if an adverse event materialises. These investments are made in various military capabilities that might be used for their primary purpose (e.g. defending the UK in a conflict), or they may pay off in ways that might not be predicted (e.g. providing Military Aid to the Civil Authority (MACA), such as building hospitals and organising medical tests in the context of the COVID-19 pandemic). There are a number of dual-use defence activities that promote prosperity, subsequently providing insurance and directly contributing to national well-being. Global examples of this are coast guard, search and rescue, para-military forces, disaster management and civil construction work of the type undertaken by the US Army Corps of Engineers. The defence as insurance analogy nonetheless has some shortcomings; for example, having flood insurance on a house does not reduce or prevent an adverse event from happening, while defence may do so through deterrence.

Insurance companies are specialists in modelling, managing and pricing risks, expressing risks in monetary terms as a premium. Noting the similarities between defence and insurance policies, it is worth further exploring how these techniques can be used in defence decision-making, and how far treating the defence budget as an insurance premium could help to clarify the defence contribution to prosperity. Insurance companies use both actuarial techniques for probabilistic calculations about common events, and more specialised techniques for rare or complex events, which may be more relevant for the defence context. Insurance companies also manage special risks insurance, for example in relation to ransom. Insurance premiums price risks – for example, shipping in the Horn of Africa region – and could accordingly be used to price the value of defence.

Insurance approaches already offer a number of applications for defence. For example, counterfactual disaster risk analysis provides a way of identifying and assessing previous situations where a disaster might

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29 In the UK, such activities are not necessarily undertaken by the military; for example, UK search and rescue is an amalgam of private industry, government departments, the emergency services and various charities and voluntary organisations.
have occurred but did not, highlighting factors that might have edged a system towards disaster and the probability of such factors arising. Indeed, counterfactual military history that asks ‘what if?’ questions about past conflicts is a well-established activity. The use of probabilistic fault trees to judge the likelihood of failure by multiple factors has also long been used by engineers attempting to ensure safe operation of complex systems (e.g. nuclear power stations), similarly offering applicability for defence. Furthermore, operational analysts use models like those used in insurance to examine certain types of event, such as kill ratios, as a function of capabilities in particular combat scenarios. This type of COIEA of expected costs and benefits can be useful in making acquisition decisions; however, aggregating to the level of a defence budget as a whole does not seem possible.

There are aspects of insurance approaches that do not translate to the UK MOD context. For example, insurance companies can choose which risks to insure and decide not to pay out if they think that the event is not covered by the policy – whereas the MOD cannot. The intangible insurance benefits of defence, security, resilience, deterrence and conflict prevention are inherently valuable but difficult to measure, model or price. Furthermore, while the risk models developed by insurance companies are often ‘tailored to specific perils’, defence often requires preparing for perils that cannot be specified in advance in a clear way. It is also worth noting that some types of insurance may be more ‘translatable’ to the defence context than others; for example, defence risks are more similar to cyber risks than to natural hazards. For defence and cyber, the landscape tends to change more rapidly and can be directly affected by the unknowable behaviour of potential adversaries – meaning that cyber-risk modelling approaches may be more relevant to UK defence.

3.3.3. Description of a defence-related equivalent

Adapting insurance industry approaches for the UK defence context could involve asking insurance-focused questions and using insurance techniques – such as existing risk models, probabilistic fault trees and counterfactual disaster risk analysis – to identify answers. However, it should be noted that attempting to place a monetary value on the defence contribution to prosperity faces some fundamental difficulties. First, while monetary values can be attached to some elements of defence, for instance through the effects of protection on insurance premiums, it is not clear how all elements can be aggregated across the defence budget. Second, any judgement about the value of defence depends on counterfactuals; that is, speculations about what would have happened had different policies been followed in the past, or predictions about what will happen if certain policies are pursued in the future. Given these difficulties, the insurance analogy is a useful way of thinking about some aspects of what defence provides, and the defence community can learn from the insurance community about how to model, manage and price specific risks. Despite these applications, it is not currently clear how insurance could be used to quantify the contribution of defence as a whole to national prosperity.

3.3.4. Possible applications and areas for further research

The insurance principle suggests that for the UK to promote prosperity through protection of its people, the UK should hedge its bets and diversify its assets to provide robust general-purpose capabilities, systems,
skills and equipment. In doing so, the UK would seek to obtain maximum flexibility to respond to a wide range of scenarios rather than gambling all of its resources by investing heavily in equipment optimised for a few specified eventualities. Using the principles and techniques from insurance, the UK MOD could consider whether risk modelling could be adapted and implemented more widely, but this requires careful framing of the question and the identification of clear boundaries for what is covered by the risk modelling. In terms of areas for further investigation, the MOD should conduct targeted consultations with insurance industry stakeholders to explore specific ways in which modelling and risk-pricing techniques could be applied in the UK defence context.

3.4. Logic models and proxy indicators (LOE4)

3.4.1. Overview of logic models and proxy indicators
Logic models and proxy indicators are used to establish the chain of causes and effects in relation to outcomes of interest. They detail inputs, activities, outputs and outcomes, and can be presented in a variety of formats. Logic models are used across a wide range of sectors, including defence, in the UK and overseas. Based on a review of various international logic models, most follow a linear structure linking inputs to processes/activities, outputs, outcomes and finally impacts. While the relationship between outputs and outcomes is often vague and unclear, some logic models have attempted to clarify the links between outputs and outcomes by providing evidence-based analysis of the interactions in a supporting narrative. Qualitative and quantitative key performance indicators are also used and can be mapped to specific outputs, outcomes and impacts through expert consultation. These indicators are often challenging to measure and require qualitative expert judgements.

An alternative to using expert judgement in defining and assessing indicators would be to identify proxy indicators that might reasonably be used to assess outputs and outcomes. This LOE explores how such proxy indicators might be developed using the lens of ‘power’ as the desired outcome of defence. This conceptualisation suggests that the measure of the final outcome and impact of defence can be conceived as the aggregate national ability to generate and apply military power (in all its forms) to achieve national strategic objectives, including the protection of the population (i.e. the primary benefits of defence). The concept of power is only one example of an approach to developing proxy indicators to assess the impact of defence – and thereby make an assessment of the benefits – but it offers useful lessons on how such proxy indicators might be operationalised either using power as a concept, or through other vehicles. However, the use of proxy indicators and logic models creates challenges as it is hard to segregate the primary and secondary benefits of defence.

3.4.2. Transferability to UK defence
In recent years, the UK Government has attempted to move away from measuring defence output by equating input to output, towards establishing direct measures of output. Despite progress, defence outcomes and benefits – such as protection and security – remain difficult to define and measure. This presents a considerable challenge in creating a logic model and proxy indicators that can fully quantify the primary benefits of UK defence, as there are several distinct ways to conceptualise the objectives of defence, and the interdependencies between the different aspects of a logic model. While there are certainly other
proxy indicators to choose from, this study tests whether the concept of ‘power’ can be used as a proxy for quantifying the protection and security of the UK from external threats.31

Whilst the complex linkages between defence inputs, activities, outputs and outcomes can be visualised as a logic model, and it is possible to define the outcomes as the primary benefits of defence, the following challenges remain around quantifying those benefits:

- A lack of a clear agreed definition of defence outputs;
- The problem of conceptualising and quantifying the value of defence capabilities or deterrence as they relate to defence’s primary benefits;
- Establishing causal linkages between outputs and the primary benefits of defence, given intermediate developments or external factors (when the outcomes and impact are defined in such a fashion); and
- Defence enjoys a distinct relationship with its ultimate clients compared to other more public-facing government services.

Whilst it cannot overcome all of these challenges, the power-based approach to developing proxy indicators has several aspects to commend it. It is supported by a long-established literature on the nature of state-to-state power, and it allows the articulation of a logical framework for how defence resources are translated into outcomes and defence benefit, namely the ability to shape the behaviours and decisions of other states and thereby protect the UK from external threats. However, it is not without its own challenges – particularly how to assign credit for activities, and the related outcomes when defence is operating alongside other departments, agencies or nations. Even by using a concept such as power, applying metrics to the components of power remains a challenge.

3.4.3. Description of a defence-related equivalent

A logic model for UK defence would provide a representative framework that enables the MOD to define the inputs, activities and outputs that contribute to the delivery of outcomes and the primary benefits of defence. However, the logic model itself does not provide a quantification of outcomes or benefits, factors that are notoriously challenging to quantify. In order to assess the different aspects of the logic model, both qualitative and quantitative indicators must be developed that can enable an assessment of different aspects of the logic model and therefore an assessment of the outcomes (including the primary benefits of defence). However, this LOE demonstrated the challenge of separating the interlaced primary and secondary benefits of defence.

Another challenge for defence is how the development of military capability, and the deterrence effect this has, can be accounted for within such a construct, particularly given the uncertainties around potential future threats and the difficulties of clearly linking the existence of defence capabilities and activities to deterring threats and thereby protection of the UK. This LOE tested a structure that includes intermediate

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31 ‘Power’ was selected as it offers a well-defined concept in the International Relations literature that sets a clear theoretical framework within which the logic model can operate. Recent theoretical work has also established a strong link between power and the objectives of national strategy and statecraft; e.g. Silove (2018), Brands (2014), Strachan (2019). This was agreed with stakeholders following a short discussion during the workshop in January 2020.
activities and outputs, which represent the development and delivery of defence policy and capability. The overarching impact is defined through the National Security Objectives (NSOs; particularly NSO1 Protect our People and NSO2 Project our Global Influence) as a representation of the primary benefits of defence.\textsuperscript{32} The logic model used the Defence Value Proposition framework to understand the value defence offers through these NSOs.\textsuperscript{33} The example logic model is provided in Annex B.

Whilst the logic model can act as a building block to help quantify the primary benefits of defence, in itself, it does not provide an assessment of benefit. Indicators are needed to assess and quantify the inputs, activities, outputs and outcomes of defence. This LOE investigated whether it is possible to use the concept of ‘power’ as a proxy for developing indicators. This seems, conceptually at least, to offer useful insights into the defence logic model and how proxy indicators might be developed. If we assume the ability to influence is the impact at the end of the logic model, and the acquisition of power is used as a proxy to represent defence outcomes, then proxy indicators could help to explore the various activities and processes that lead there. Based on the work of Joseph Nye, this LOE demonstrated a typology of power (Figure 3-1), which could capture and categorise the generic ways that different countries employ power in their national defence strategies. This approach assumes that the ultimate goal of defence inputs is the ability to shape the international system as one would wish (power); that the ability to shape the system will enable the UK to protect itself from external threats; and that different intermediate forms of power are achieved through particular activities.

This typology of power offers some possibilities for developing indicators that can then be used to assess aspects of the defence logic model. For example, in Figure 3-1, the typology suggests that the number and success of sanctions might provide an indication of coercive power. By developing and mapping indicators of power onto the logic model, they could be used as a proxy for assessing the outcomes and, to some extent, benefits of defence.

\textsuperscript{32} Whilst this mapping is potentially overly simplistic, for the purposes of this exploratory study it provides a means to test this approach.

\textsuperscript{33} Black et al. (2020).
3.4.4. Possible applications and areas for further research

The approach examined in this LOE highlights a potential course towards developing a framework that can help to articulate how defence inputs can be turned into primary benefits. By defining appropriate outcomes and impacts for the logic model, such an approach may help the MOD to better understand how defence's primary benefits can be broken down and assessed by proxy. This approach alone will not provide a single quantifiable measure for assessing these primary benefits, and it will require assumptions to be made about what can and cannot be used as proxies for different aspects of defence activity and output. However, such a methodology could provide the MOD with a building block to improve understanding of defence's contribution to national prosperity.

Further development would be required to implement such an approach, but this study has made some progress in designing a logical and – conceptually – reasonably robust model based on the concept of power. Any further research should focus initially on developing a more comprehensive logic model and focusing this model on understanding how different aspects of defence contribute to the primary benefits of defence. It should also seek to identify interdependencies with non-defence activity and outputs that contribute to the protection of the UK. This will be challenging, but understanding the unique contributions that are brought about by defence spending is important. Furthermore, research should be undertaken to identify alternative concepts for developing proxy indicators, beyond the power-based approach. By identifying alternative concepts, a more comprehensive set of proxy indicators can be developed, which in turn should provide improvements in the approach.

3.5. Discrete choice experiments (LOE5)

3.5.1. Overview of discrete choice experiments (DCEs)

DCEs consist of a quantitative economic methodology to elicit preferences and quantify non-market goods, e.g. the protection of UK citizens. This methodology allows valuations of a good or service to be separated into component parts, providing unique insights on the trade-offs between these components. DCEs are
part of the suite of stated preference (SP) methods recommended by HM Government for valuing non-market goods and services. SP methods generally rely on surveys and present participants with hypothetical questions. There are two main SP approaches:

- **Contingent valuation methods (CVM)** involve asking people to directly estimate the total value of a good or service (e.g. ‘how much would you be willing to pay for clear air’); and

- **Discrete choice experiments (DCEs)** involve asking participants to choose between hypothetical goods or services (e.g. clean air or reduced noise levels).

As indicated in Section 3.2 (LOE2), DCEs are less open to manipulation by respondents than other SP methodologies, and may therefore produce less biased results. Furthermore, DCEs offer a way of evaluating goods and services, and the researcher can control both the choices presented to individuals and the correlation between attributes. DCEs are data-efficient, as respondents can be presented with more than one choice scenario within an interview. However, the data collected are based around what individuals say they would do in hypothetical situations, rather than revealing real-world choices. This challenge is important to consider when assessing DCEs.

### 3.5.2. Transferability to UK defence

DCE methods have been used in a range of sectors, but they do not appear to have been used to explore the overarching value of defence to UK citizens. Applications of SP techniques include travel demand analysis, valuation of accidents, atmospheric pollution, environmental science, evaluation of aircraft noise, health economics and politics. Most of the existing evidence on the use of DCEs in the defence and security context is focused on specific aspects, such as public preferences for security measures protecting against the risks of aviation terrorism or the impact of travel advisory information relating to terrorism on tourists’ decision making.

As noted above, when compared to other public services such as health, transport or education, the primary benefits of defence (i.e. security and protection) are difficult to define and measure. Furthermore, citizens tend to have less tangible experience of interactions with defence compared to – for example – their transport service needs and experience of travel delays. This creates challenges in developing an appropriate experiment that the public can understand and respond to, but which represents the complexities of how defence contributes to national prosperity through the primary economic benefits it delivers.

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34 List & Gallet (2001).
38 Adamowicz et al. (1998).
40 Sussex et al. (2019).
41 Lu et al. (2020).
42 Veisten et al. (2011).
43 Walters et al. (2019).
Developing DCEs is nonetheless worth exploring, as they allow policymakers to estimate how much of one component (e.g. deterring international conflicts) the public would be willing to give up in order to have an improvement on another (e.g. supporting the national economy). DCEs also offer a natural application for military personnel planners in terms of understanding the relative value that individuals place on different elements of the defence employment offer (e.g. financial incentives, training opportunities). This methodology accordingly provides quantifiable data that can help guide appropriate strategies for the prioritisation of defence activities and outcomes.

3.5.3. Description of a defence-related equivalent

The study team designed and tested a pilot survey to explore how DCEs could be operationalised in the defence context. With a relatively small sample size (n=210), the survey nonetheless covered a range of ages, genders and geographical regions. A set of questions was posed to participants in order to develop an improved understanding of the attitudes of citizens towards various defence activities and outputs. Four core attributes of UK defence were used to frame the questionnaire design. These attributes represented a consolidated version of the six core aspects of defence value, as defined in a 2020 study on the UK Defence Value Proposition (DVP). The core attributes of defence that were assessed during the DCE were:

- Protection of UK citizens;
- International security and global influence;
- Support to the national economy; and
- Contribution to national identity and social welfare.

These attributes of defence were selected in consultation with the Dstl client to represent the primary and secondary benefits of UK defence. The purpose for considering both was to compare people’s perceptions of primary vs secondary benefits. An additional reason for covering both was that secondary benefits can increase national prosperity through ‘social value’, which is part of the focus of this project. This was felt to be a useful addition to the experiment, given the exploratory nature of this work and because it offered insights into the public understanding of the different types of benefits provided by defence.

A key aspect of any DCE is to design a payment vehicle (cost attribute) that enables a calculation of the public’s willingness to pay for each attribute level. Within the scope of this short pilot study, it was only possible to identify a simple cost attribute, which was based on a simple average cost of defence investment per household per month. This was recognised to be a very simplistic measure of defence costs, but it was sufficient to test the methodology, which was the overarching intention of this study.

Based on this pilot study, the DCE method was demonstrated to have potential to help the MOD understand the public’s willingness to pay for defence. This is particularly positive given that DCEs could be used in conjunction with the approaches in LOE1 (QALYs) and LOE2 (VSL) to help understand willingness to pay. Respondents engaged with the survey, with 93.3% of respondents reporting that they were able to understand the characteristics of the different choices presented to them, including those focused on the primary benefits of defence. Clearly, these results should be treated with caution given the

44 Black et al. (2020).
relatively small sample size (n=210) but they do demonstrate that DCEs could form one component of a broader approach to quantifying the primary benefits of defence.

Whilst the pilot survey demonstrates that the DCE design works as intended, the survey did not account for the opportunity costs in defence. Opportunity costs are defined as the opportunities that are lost when an alternative option is selected. The opportunity costs of defence are the costs associated with defence investment, which result in the UK Government not being able to spend that money in other areas. Within defence, the opportunity costs are the alternative options that defence has chosen not to take (i.e. the different ways that the same objectives could be achieved). Any full-scale DCE that intends to assess the public’s willingness to pay for the benefits of defence would need to incorporate questions that address the opportunity costs of defence, as they are key to understanding the social value of defence and therefore the contribution to national prosperity. For the purpose of the pilot DCE, it was agreed with the Dstl client that opportunity costs would not be considered because they are a challenging concept for members of the public who lack familiarity with defence concepts and processes to understand. The limited scope of this exploratory pilot study required certain design compromises to be made, and it was decided that sufficient justice could not be done to any attempts to incorporate the important but complex concept of opportunity costs.

A number of other design choices had to be made due to the limited scope of the pilot study. Any full-scale DCE that attempts to understand the public perception of defence should reconsider whether the design should be adapted to account for the following decisions:

- Participants were not provided with a brief on defence issues before they took the survey. This was to ensure that the DCE captured representative views of ‘real people’ whose knowledge of defence may be mixed. Using an ‘informed choice’ could bias responses and compromise understanding of current public perspectives about defence. Respondents’ wider value perceptions (e.g. pacifist views) may also bias responses in a way that is not reflected in non-defence DCE contexts.

- In the time available, it was not possible to explore some of the more nuanced overlaps and interdependencies between the MOD and other government departments in relation to contributions to UK national security. Nor was it possible to account for the complexities of the UK’s contribution to international security organisations – such as NATO – and the consequent risks and opportunities in global security and protection of the UK. Any full-scale DCE should consider whether this can be explored further.

- The costs of defence used in this study employed a representative figure for ‘cost per household per month’. This was selected as a simple measure for the participants to understand, due to the time constraints of the work that prevented a more comprehensive cost attribute being developed for defence. A full-scale DCE should consider how costs can be articulated in a more representative fashion.

3.5.4. Possible applications and areas for further research

The objective of this pilot survey was to design a DCE and provide a proof of concept for comparing public perceptions of priorities within defence and the value of defence more generally. The results from this survey show that this is indeed possible, although a number of improvements should be considered to ensure any
such DCE addresses the overarching value of defence to the greatest extent possible. In the future, it would be useful to run a DCE with a larger sample to obtain more representative findings and to explore how valuations vary across different segments of the population. Multiple DCEs could also be run to explore different aspects of how the UK benefits from defence – through protection from external threats – and further investigate other influences on UK protection and security, such as other government departments, other national defence organisations and international organisations such as NATO. The DCE approach could also be used to capture underpinning data on the public willingness to pay for defence that could be used to help in the development of other approaches, particularly PALYs (LOE1) or VSLs (LOE2). Used in these various fashions, DCEs could form a building block for improving the UK’s understanding, and represent an approach to quantifying defence’s contribution to national prosperity.

The overall cost of a large-scale survey will depend on data-collection and data-analysis costs. Data-collection costs depend largely on the recruitment approach, the length of the survey and the necessary sample size, and data-analysis costs depend on the complexity and level of market segmentation analysis required. In terms of timescales, implementing a survey and DCE could take 4–8 months (or longer).
This chapter presents a simple assessment framework that is intended to depict the extent to which the individual LOE methodologies can be used to assess defence’s contribution to national prosperity and defence activity.

4.1. **Purpose of the assessment framework**

The individual LOEs, as described in earlier chapters, investigated the potential of different methods to assess the primary benefits of defence (i.e. protecting the UK from external threats). These LOEs have looked at the approaches independently and demonstrated that there appears to be no single approach that can fully quantify those benefits. In light of this, RAND Europe has drawn together insights from the LOEs to create a simple assessment framework that demonstrates the potential utility of different approaches within the overarching defence context. The framework also suggests how the approaches might be used in combination to quantify the benefits of defence. This work is based on expert judgement drawn from RAND Europe, academic partners and other stakeholders. It was not possible within the scope of this research study to test multi-method approaches to quantifying the primary benefits of defence, and further research should be undertaken to develop such an approach.

At the outset of this study, RAND Europe proposed a simple assessment framework to map each LOE against individual defence activities, defined in terms of military operation types (e.g. MACA, defence engagement, high intensity warfighting, etc.). However, after the stakeholder workshop held in September 2020, and subsequent discussions with Dstl, it was concluded that the LOE approaches showed promise in assessing the overall primary benefits, as well as the outputs and outcomes of defence to varying degrees. The research did not identify any potential differentiation in the ability of individual LOEs to assess different types of defence activity. As such, the assessment framework uses relevant components of social value as per the HM Treasury Green Book and the core aspects of the logic model as defined in Section 3.4 (i.e. defence inputs, activities, outputs and outcomes). Assessing the LOEs against social value was deemed important, since it is the foundation of evaluating and appraising all government policies, programmes and projects within the HM Treasury Green Book.

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45 HM Treasury (2020).
In the original proposal, the RAND Europe team also offered to explore whether a flowchart could be developed to guide the evaluation and appraisal process in relation to determining benefits brought about by UK Defence activities in terms of the primary economic benefits. It has not been possible to develop an assessment of how these approaches might integrate into the evaluation and appraisal process at this stage. Any such flowchart would require further development of the individual approaches to provide the granularity required. Such in-depth research was not within the scope of this study; however, recommendations on further research that would support such an effort are provided in the individual LOE chapters.

4.2. The assessment framework

The development of the assessment framework was led by RAND Europe but drew on expert judgement from academic partners, Dstl, ASC Technical Lead and the MOD. A number of activities were undertaken to cultivate ideas and generate the final version of the assessment framework. These were:

- Internal RAND Europe workshop to develop the overarching concept and structure;
- Stakeholder presentations to review overarching structure and approach;
- Desk-based review of all LOE research to map them onto the framework;
- Discussions with academic partners to refine the mapping articulated;
- Stakeholder reviews, including comments on the structure and mapping; and
- Internal workshop to produce final framework, including rationalising differing viewpoints from various stakeholder groups.

The aim for the final assessment framework was to simplify a substantial amount of research into an easy-to-understand framework. The key challenge was distilling the nuanced findings from across the five LOEs, whilst also incorporating a variety of perspectives from across the project team and stakeholder community. However, mapping the LOEs to the different aspects of defence is important for understanding how applicable – both individually and collectively – the LOE methods are to assessing defence’s contribution to national prosperity.

Table 4-1 summarises the mapping from each LOE onto both the defence logic model and the benefits of defence. For LOE4, the mapping represents the use of power as a proxy indicator (i.e. it does not map the defence logic model from LOE4 onto itself).

The assessment framework focuses on whether individual approaches might contribute to quantifying the inputs, activities, outputs and outcomes of defence. The MOD is also interested in whether it is possible to provide a monetisable assessment of these benefits. Whilst this has always been challenging within the defence context and it has only been possible to consider this conceptually within the LOEs, the application of LOE2 in other sectors has demonstrated that VSL can be used to develop a monetised value of lives saved (e.g. DfT assessment of lives saved on UK roads). PALYs may also offer the potential of monetising the value of reducing the risk if costs are incorporated into the development of such an approach.
Table 4-1 LOE assessment framework

<table>
<thead>
<tr>
<th>LOE</th>
<th>Defence inputs</th>
<th>Defence activities</th>
<th>Defence outputs</th>
<th>Defence outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOE1 PALLYs</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>LOE2 VSL</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>LOE3 Insurance Techniques</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>LOE4 Logic model &amp; proxy indicators</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>LOE5 DCE</td>
<td>No*</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

The approach does not appear to be capable of assessing or quantifying this aspect of defence, based on the research in this study.

The approach appears to offer a way of assessing or quantifying this aspect of defence, based on the research in this study.

* Whilst DCEs were not used to assess defence inputs, it should be possible to redesign the DCE survey to capture public perceptions of defence inputs.
4.3. Conclusions from the assessment framework

The assessment framework demonstrates that in order to measure defence’s contribution to national prosperity, a number of approaches are likely to be required, as no single approach provides a full coverage of the problem space. If the approaches from this study were developed, then the MOD could be better positioned to quantify (and possibly monetise) the primary benefits of UK defence.

PALYS, VSL and the proxy indicators of power (LOE1, LOE2 and LOE4) all offer potential approaches that could help defence in quantifying the overall outcomes and benefits of UK defence. PALYS and VSL would need to draw heavily on public and expert opinion to generate the relevant underlying data, but each offers an alternative perspective on how the benefits of defence might be valued. In addition, the PALYS and VSL approaches provide potential measures of overarching social value in terms of both the economic and social benefits of defence. The use of proxy indicators would require the MOD to identify some alternative concepts and indicators that could be used as a proxy for the benefits of defence. If selected appropriately, these proxy indicators may provide a presentative quantification of the social value of defence, although this would need further research and would only offer proxy quantification of defence benefit by its very nature. The use of proxy indicators offers an interesting approach that would enable defence to link different components of the logic model and produce an overarching assessment of the primary benefits of defence.

Insurance techniques (LOE3) do not offer any obvious approaches to assessing the primary benefits of defence, and therefore LOE3 does not map readily to any aspects of the assessment framework. Based on the findings related to LOE3, this is perhaps unsurprising. Nevertheless, this does not mean that LOE3 provides no value to defence decision-making, and defence may wish to further explore the use of insurance techniques to consider risk, given the existence of established risk-modelling tools in the insurance industry and the need to assess a range of risks in defence planning and prioritisation. But in terms of this framework, no further research is needed on this approach.
5. Conclusions and implications for defence

Despite the growing policy emphasis on understanding the value of UK defence, assessing the primary benefits of defence remains a challenge. Defence is inherently complex, and it remains difficult to prove that the non-occurrence of an event (e.g., conflict) is directly related to the existence of defence capabilities and activities. Linked to these challenges, connecting defence activity and output to defence outcomes and wider benefit remains elusive.

This study has explored the potential of five methodologies (LOEs) to measure the contribution of defence to UK prosperity by assessing its primary benefits. A range of insights for the MOD have been identified on how to apply and further develop these methodologies towards measuring the benefits of UK defence as a whole.

It is vital that the MOD considers how the methods investigated in this study can be layered or combined to understand how the primary benefits of defence can be measured. The previous chapter described a simple assessment framework for improving the understanding of how each LOE contributes to assessing different parts of defence. This framework offers a starting point for supporting an enhanced understanding of the value offered by UK defence.

5.1. Opportunities and challenges for defence

Based on the research into the five individual methodologies, it is apparent that each offers opportunities that could assist defence decision-making and pave the way for an improved understanding of defence’s contribution to prosperity. PALYs (LOE1), VSL (LOE2), Logic models and proxy indicators (LOE4) and DCE (LOE5) can all contribute to assessing the primary benefits of defence. Insurance techniques (LOE3) do not appear to offer such an approach for assessing these same benefits; however, actionable approaches can nonetheless be identified from insurance companies for conceptualising, measuring, managing and pricing defence risks.

Table 5-1 provides a summary of the opportunities that each of the LOEs might offer for the MOD in measuring its primary benefits. The table includes a structured synopsis of the relevance of the method and feasibility of implementing it within the defence context. This analysis compares each method using a

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simplified Heilmeier Catechism to sum up the key findings from this study. The following factors were used for this comparison:

- **Opportunities for defence**: what opportunities are available to defence if such an approach were taken to quantifying the primary benefits of defence?

- **Relevance to defence**: to what extent could the approach be used to meet the objective of quantifying the primary benefits of defence?

- **Feasibility of implementation**: how easy or practical would the approach be to implement in terms of time and resources?

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47 George Heilmeier designed a set of questions to help DARPA officials assess proposed research programmes; DARPA (n.d.).
<table>
<thead>
<tr>
<th>LOE</th>
<th>Opportunities for defence</th>
<th>Relevance to defence</th>
<th>Feasibility of Implementation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Defence analogue to QALYs (LOE1)</td>
<td>PALYs could be used to quantify the benefits of new defence policy, capabilities, tactics and technologies in terms of cost effectiveness. Cost per PALY could be used to assess the cost benefits and potentially monetise the assessment and draw comparisons. By assessing the outcomes of defence, PALYs could be used to provide a quantified assessment of defence’s primary benefits. By investing the necessary time and cost in developing PALYs, defence could improve its ability to quantify primary benefits and assess the cost benefit of defence investment options.</td>
<td>Defence and health contexts vary, requiring a bespoke PALYs methodology to be designed to account for these differences. In its current form, QALYs do not account for certain features of defence (e.g. citizens being less likely to be able to assess external threats to UK security, but more accurately able to assess the state of their health). PALYs offer a way to assess the cost-effectiveness of policies, capabilities and technologies and provide a quantifiable/monetisable measurement of defence outputs and outcomes.</td>
<td>The cost and time burden for adapting QALYs to defence is substantial, and would require time, resource and stakeholder consultation. Based on the work required for QALYs, it could take at least 2–3 years to fully develop PALYs, depending on the resource available. It is estimated that PALYs would require military expertise panels and public panels that engage in the region of 1,000 people. Engaging with QALYs centres of expertise would help the MOD leverage existing expertise and gain efficiencies to adapt QALYs for defence.</td>
</tr>
<tr>
<td>LOE</td>
<td>Opportunities for defence</td>
<td>Relevance to defence</td>
<td>Feasibility of Implementation</td>
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<tr>
<td>VSL could be used to assess the benefit of different investment options by identifying which capability can provide the best value for money in a like-for-like situation, offering utility for defence stakeholders when considering whether to replace or upgrade given capabilities.</td>
<td>VSL methods offer some applications for defence (e.g. decision making on safety modifications intended to reduce the risk of death or injury to service personnel). Through DCEs (LOE5), VSL could also shed light on UK society's willingness to pay for defence spending increases to reduce the likelihood of death. All approaches to identifying a definitive monetary value for the VSL are challenging. This reflects the inherent challenges affecting RP, CV and other available techniques, which have limitations for accurately estimating trade-offs between money and risk. It is difficult to produce reliable estimates on the number of lives saved from MOD spending increases.</td>
<td>Several VSL approaches were identified with potential transferability to defence (e.g. US homeland security &amp; DfT cost-benefit analysis), which should reduce the burden of developing this approach. Any development of VSL would require time to develop the underpinning evidence on the public’s willingness to pay through DCEs or other approaches. It is likely to require 1–2 years of development, including DCEs, to generate the necessary understanding of the public’s willingness to pay for defence, and to make this approach feasible. Approaches similar to VSL are already being used in defence and thus, it is likely to be easier to gain buy-in or acceptance from senior decision-makers.</td>
<td></td>
</tr>
<tr>
<td>VSL methodologies could be used in decision making on safety modifications intended to reduce the risk of death or injury to service personnel.</td>
<td>It is difficult to place a value on defence as an insurance premium as this relies on counterfactuals and a degree of speculation. Some aspects of insurance do not translate to the MOD context; e.g. insurance companies are able to choose which risks to insure and can decide not to pay out (the MOD lacks this ability). Insurance approaches do not offer a way of supporting a holistic assessment of primary benefits across defence – but do offer other insights and applications. Some types of insurance are more ‘translatable’ to defence (e.g. cyber risks more so than natural hazards, given the role of adversaries and the pace of change). While monetary values can be attached to some elements of defence (e.g. effects of protection on insurance premiums), it is not clear how all elements can be aggregated across defence.</td>
<td>This study has concluded that it would not be feasible to use insurance techniques to quantify the primary benefits of defence. Conceptualising defence risk by using an insurance-based approach should be relatively quick (less than a year), as it involves mapping insurance concepts into a defence context. Developing defence risk-modelling and pricing using these techniques would require more time given the resources required to adapt the modelling and assessment techniques.</td>
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</table>

**Insurance policy techniques (LOE3)**

Specialised insurance techniques for modelling, managing and pricing risks offer relevance for defence decision-making, as it relates to risk management. Adapting insurance approaches for defence could involve asking insurance-focused questions and addressing these using insurance techniques (e.g. probabilistic fault trees, counterfactual risk analysis).

It is difficult to place a value on defence as an insurance premium as this relies on counterfactuals and a degree of speculation.

Some aspects of insurance do not translate to the MOD context; e.g. insurance companies are able to choose which risks to insure and can decide not to pay out (the MOD lacks this ability). Insurance approaches do not offer a way of supporting a holistic assessment of primary benefits across defence – but do offer other insights and applications. Some types of insurance are more ‘translatable’ to defence (e.g. cyber risks more so than natural hazards, given the role of adversaries and the pace of change). While monetary values can be attached to some elements of defence (e.g. effects of protection on insurance premiums), it is not clear how all elements can be aggregated across defence.

This study has concluded that it would not be feasible to use insurance techniques to quantify the primary benefits of defence. Conceptualising defence risk by using an insurance-based approach should be relatively quick (less than a year), as it involves mapping insurance concepts into a defence context. Developing defence risk-modelling and pricing using these techniques would require more time given the resources required to adapt the modelling and assessment techniques.
### Logic models and proxy indicators (LOE4)

<table>
<thead>
<tr>
<th>LOE</th>
<th>Opportunities for defence</th>
<th>Relevance to defence</th>
<th>Feasibility of Implementation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Logic models and proxy indicators</td>
<td>Logic models could provide a useful framework for defence to conceptualise the links and interdependencies between inputs and impacts, allowing defence to better articulate how its inputs contribute to delivering primary benefits. Proxy indicators offer the potential to assess primary defence benefits (in terms of outcomes) where direct measures are unavailable.</td>
<td>A range of logic models are already used in defence or have historically been used (e.g. UKCeMGA’s model, NZDF framework). Enduring challenges include problems in conceptualising the value of defence capabilities or deterrence, and the challenge of establishing causal linkages between outputs and ultimate outcomes. A linear model does not reveal real-life complexities (e.g. power is not unidirectional). It can be difficult to clearly link outcomes to specific activities and actors. This approach would require a combination of quantitative and qualitative indicators to be developed.</td>
<td>UK defence already employs logic models and proxy indicators in some of its decision making to evaluate various operations, programmes and projects. Developing an overarching logic model for defence could take anything from 6 months upwards, depending on the level of effort and buy-in obtained. Developing proxy indicators is likely to take at least 3 months, but could be phased with the development of the logic model. It would require initial research to identify suitable proxy concepts and to map these onto defence outputs and outcomes – in the way this study has used the concept of ‘power’. However, a substantial amount of resource would be needed to develop and implement a data-collection plan for assessing these indicators.</td>
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</table>

### Discrete choice experiments (LOE5)

<table>
<thead>
<tr>
<th>LOE</th>
<th>Opportunities for defence</th>
<th>Relevance to defence</th>
<th>Feasibility of Implementation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discrete choice experiments</td>
<td>DCEs allow policymakers to estimate how much of one component (e.g. deterring international conflicts) the public would be willing to give up in order to improve another (e.g. supporting the UK economy). It is possible to compare public perceptions of primary defence benefits and opportunity costs through DCEs, offering a foundation for quantifying those benefits in terms of public perceptions and developing other approaches, such as VSL.</td>
<td>Compared to other public services, defence outputs are hard to define and measure, creating challenges for the design of DCEs. Fully representing the benefits and opportunity costs of defence within a DCE is likely to be a challenging endeavour, but is key to developing an assessment of the primary benefits of defence. The pilot survey shows that this method holds promise and – with refinement and wider rollout – will offer defence a clear indication of the value placed on it by UK citizens.</td>
<td>People may value defence outcomes differently, depending on their background. It is estimated that any DCE would need to employ a sample size of 2,000 to 5,000 respondents and to explore statistically how valuations vary across the population. The timescales for undertaking a larger study will depend on research design (the degree of modification to the current survey), the data-collection approach and complexity of data analysis. It could range from 4 to 8 months or longer if a substantial design is required. The cost of a large-scale survey will depend on data-collection cost and data-analysis cost (resources).</td>
</tr>
</tbody>
</table>
5.2. Avenues for further exploration

There is no silver-bullet solution to assessing the primary benefits of defence. However – as outlined in Section 5.1 – the investigated LOEs offer actionable insights and approaches that can be adapted to support this assessment. It is unlikely that defence will be able to produce a single overarching measure of its primary benefits, but it is possible to improve upon the often-used approach of equating defence input to output.

The MOD should consider taking forward the research from this study in the following ways:

- **Develop an improved understanding of how defence contributes to national prosperity**, by further developing and refining a logic model (LOE4) to represent how defence inputs lead to primary benefits. Such a logic model would also provide a framework to articulate all primary and secondary benefits of defence and the links between them.

- **Improve the understanding and quantification of public perceptions of defence**, including in terms of its social value, opportunity costs and the willingness of the public to pay for defence. This would be achieved through a DCE (LOE5) that is delivered through a representative survey of the UK population.

- **Consider the development of new approaches to quantify (and possibly monetise) the benefits of defence**, especially PALYs (LOE1) and VSL (LOE2). In particular, the MOD could engage experts in the health sector to understand what lessons can be learned. Both approaches offer possibilities for measuring the relative cost-benefit of different defence investment options. This is likely to require significant investment, so the MOD must determine whether these costs are prohibitive given the lessons of developing QALYs for health.

- **Employ proxy concepts for assessing the benefits of defence** where actual measures of benefit cannot be identified or developed. The MOD could conduct further research into alternative concepts for proxy indicators to determine how these might usefully complement the work on the power-based approach. Whilst this has limitations, it would enable defence to identify proxy indicators for the primary benefits of defence (LOE4) beyond simply measuring defence inputs and activities.

- **Engage with insurance industries** to identify which techniques might help to improve the MOD’s management, modelling and pricing of defence risk. The MOD could benefit from identifying specific techniques that might have applicability to defence as well as understanding how to think about defence as an insurance policy.

- **Apply each assessment framework** to a particular area, such as a specific mission-type, to test the application of multiple methods to a specific question of quantifying the primary benefits of defence. This should help to further refine the framework and identify potential gaps.


McCabe, C. 2009. ‘What is cost-utility analysis?’ What is …? Series, Hayward Medical Communications, Hayward Group.


Annex A. Definitions

This appendix outlines a set of definitions for selected key terms used in this report. This is based primarily on existing definitions provided by UK Government documents within and outside of defence, with additional edits and suggestions by the study team where deemed necessary to ensure coherence.

A.1. Format of this lexicon

Key terms are listed in alphabetical order, according to the following model:

[TERM]: Definition as proposed by the study team, or as endorsing an existing definition in use elsewhere across UK Government (e.g. in the Green Book), if applicable.

• TERM: Definition #2, if multiple contested definitions are available in the literature – Source document (date) for definition, if applicable.

• RELATED TERM: Definition of related terminology, or variations on similar ideas (e.g. different types of value).

A.2. Definitions for the purpose of this research

Benefits: Benefits refer to increases, advantages or added-value generated by an endogenous or external action, be it economic, social or political. Benefits are many-sided; they can be direct and/or indirect.

• Social Benefits. 'Social benefits are the total increase in the welfare of society from an economic action – the sum of the benefit to the agent performing the action plus the benefit accruing to society as a result of the action (external benefits).’ – HM Treasury (2020) The Green Book

• Indirect/External Benefits. 'Indirect/external benefits are benefits of production or consumption of a good which are not taken into account by individuals or included in the price of a good in a perfectly competitive market.’ – HM Treasury (2020) The Green Book

• Primary Benefits. 'The primary contribution of defence to UK prosperity is the protection it provides from external threats and aggression, which allows the economy to function peacefully. Defence also supports the international rules-based system in which growth in the world economy can take place and from which the UK benefits.’ – Dunne Review (2018)

• Secondary Benefits. The wider economic impact of defence spending on knowledge creation, innovation and research & development, positive regional impacts arising from defence activities or other beneficial spillovers into the civilian economy.
**Client/Customer/User**: These terms refer to the recipient(s) of a value proposition.

- Depending on context, perspective and prioritisation, that could encompass a number of different entities, including internal (i.e. military and civilian personnel), cross-government (i.e. OGDs, the State), domestic (i.e. the general population) or international (e.g. allies, partners or even adversaries).

**Costs**: Costs refer to decreases or disadvantages generated by an endogenous or external action, be it economic, social or political. Costs are many-sided; they can be direct and/or indirect; economic, social and/or political.

- Social Cost. 'Social cost is the total cost to society of an economic activity – the sum of the opportunity costs of the resources used by the agent carrying out the activity, plus any additional costs imposed on society from the activity (external costs).’ – *HM Treasury (2020) The Green Book*

- Indirect/External Costs. 'Indirect/external costs are costs of production or consumption of a good which are not taken into account by individuals or included in the price of a good in a perfectly competitive market.' – *HM Treasury (2020) The Green Book*

**Defence**: Defence covers all those matters that are the responsibility of the Secretary of State for Defence. In practice this means the business of the Secretary of State and how fellow ministers of the Ministry of Defence – as the department of state – supports them, and of the armed forces as constituted by an Act of Parliament. – *UK MOD (2015) How Defence Works*

- The Whole Force: The term ‘whole force’ describes the organisations, resources and people, both military and non-military, involved in delivering defence’s outputs. A Whole Force approach is therefore a capability comprised of the right mix of people from regular and regular reserve forces, the Civil Service, academia, industry partners and contractors, combined with both military and non-military organisations and resources to deliver a defence output. – *UK MOD (2014) Joint Doctrine Publication 0-01: UK defence doctrine (fifth edition)*

**Disbenefit**: A disbenefit is the measurable decline resulting from an outcome perceived as a negative by one or more stakeholders. Disbenefits are a negative consequence as a result of a project/intervention. They should follow similar activities and processes as benefits management, and are typically identified, categorised, quantified and measured in the same way benefits are. – *UK Infrastructure & Projects Agency (2017) Guide for Effective Benefits Management in Major Projects*

**Impact(s)**:

- Impact: Impacts refer to the longer term effects of the proposal on the well-being of the UK public. It is the wider public value attributable to the proposal. – *Department for Transport (2017) Value for Money Framework*

- Impact: Goods or services produced from inputs (activities may be substituted where outputs are difficult to measure). – *HM Treasury (2019) Public Value Framework*
• Impact: ‘The intended impact of spending public money, i.e. the objectives sought by government. They can be either direct (usually measurable and timely) or indirect.’ – HM Treasury (2019) Public Value Framework

**Inputs:** Inputs refer to the amount of resources – be they economic, social or political – spent or given to deliver specific outputs and outcomes through processes.

• Inputs: Resources that are purchased using public money – HM Treasury (2019) Public Value Framework

**Logic Model:** A logic model is a graphic which represents the theory of how an intervention produces its outcomes. It represents, in a simplified way, a hypothesis or ‘theory of change’ about how an intervention works. – Public Health England (2018) Introduction to Logic Models

• The terms used in logic models vary, but they commonly include the following aspects: inputs/resources; processes/implementation; outputs; outcomes/impact; and a description of the context and relationships between each of these elements.

**Outputs and Outcomes:** Outputs refer to the direct immediate-term results of processes or activities. Outcomes can be intended, or unintended consequences and effects produced by the delivery of outputs and the interaction with other external actors or variables. They are often not immediately seen and, even when seen, may be difficult to attribute back to any given output or decision, due to the complex interplay between different variables.

• Output: Output refers to the change in the level or quality of a service delivered. For example, more cardiovascular operations carried out. – HM Treasury (2020) The Green Book

• Outcomes: Outcomes refer to the consequences to society of a change in service or policy. For example, improved life expectancy of the population. – HM Treasury (2020) The Green Book

• Outcomes: Outcomes refer to the short- and medium-term results of the proposal which may affect public value. – Department for Transport (2017) Value for Money Framework

• Traditionally, defence outputs were measured on an input basis where inputs were assumed to equal outputs. In fact, defence outputs are a complex set of variables concerned with security, protection, risk management, including risks and conflicts avoided, safety, peace and stability. – K. Hartley (2012) Conflict and Defence output: An economic perspective

• Additionally, ‘outputs and objectives have a complex relationship. Most objectives require us to deliver multiple outputs, and many outputs serve more than one objective.’ – MOD (2015) Joint Doctrine Note 1/15: Defence Engagement

**Processes/Activities:** Processes or activities encompass the combination of ends, ways and means to transform inputs into outputs so as to deliver (it is hoped) the desired outcomes. In a wider defence context, this can include defined or informal practices for the conduct of policymaking and planning; governance and organisational management; financing; capability development and acquisition; innovation; force development and generation, etc.
• Ends: Ends articulate the political intentions of the UK Government for any specific campaign, expressed as outcomes and strategic objectives. – MOD (2016) Joint Doctrine Publication 05

• Ways: Ways seek to map a path from the current position to the desired political outcome. This will identify the specific strategic objectives that need to be met to facilitate the requisite change. – MOD (2016) Joint Doctrine Publication 05

• Means: Means include critical capabilities that can support national security objectives. – MOD (2016) Joint Doctrine Publication 05

Process Evaluation:

• Process Evaluation: Process evaluation aims to explain how complex interventions work. They are especially useful for interventions that include a number of interacting components operating in different ways and also when interventions address complex problems or seek to generate multiple outcomes. The purpose of a process evaluation is to explain how an intervention generates outcomes or effects. – Public Health England (2018) Process Evaluation Guidance

• Process Evaluation: Process evaluation primarily aims to understand the process of how a policy has been implemented and delivered and identify factors that have helped or hindered its effectiveness. It can take place at any time that the policy is being delivered (the timing of the evaluation will depend on the policy and research questions that need to be answered). Process evaluation can generate a detailed description of what interventions are involved in a service or policy, who provides them, what form they take, how they are delivered and how they are experienced by the participants and those who deliver them. It can also provide an in-depth understanding of the decisions, choices and judgments involved, how and why they are made and what shapes this. – HM Treasury (2020) The Magenta Book

Prosperity: Prosperity is measured by the level of social value as defined in the Green Book, so that an increase in social value is an increase in prosperity and a decrease in social value is a fall in prosperity. – HM Treasury (2018) The Green Book

• Prosperity: The stability needed for economic development and the security required for international trade, as well as strong role for defence engagement and its global network in cultivating the relationships that will support business and exports. – MOD (2017) UK’s International Defence Engagement Strategy

• Prosperity: Defence makes possible our secure domestic environment and rules-based international order so that we can live and prosper, protected from the devastation of war and the impact of terrorism. It also enables many of the benefits we rely on to conduct our daily lives. It protects the trade routes that carry the goods we consume. It guards the underwater cables and satellites that convey the communications which connect us with other nations. It counters the cyber-attacks that could bring our technologically dependent lives to a standstill. Virtually invisible, this protection underpins our economic growth. – Dunne Review (2018)
Primary Economic Benefits: The contribution of defence in providing protection from external threats to enable the UK economy, trade and society to prosper.

Secondary Economic Benefits: The contribution of defence in terms of the economic impact arising from knowledge creation, innovation and research & development, positive regional impacts arising from defence activities and other beneficial spillovers into the civilian economy. These benefits are typically more direct and immediately tangible economic benefits of defence.

**Public Good**: ‘It is produced for the community, and differs from private goods in that it is consumed by all citizens equally whereas private goods are consumed individually and exclusively by those who purchase them; once a public good such as defence is produced it does not matter whether an individual has paid taxes or not, his consumption of defence cannot be exclusive at the expense of fellow citizens, nor can it be limited by the consumption of other citizens.’ (Adam Smith) – Quot. in Matthews (2019) The Political Economy of Defence, page 3

**Value**: Value is a measure of the benefit provided by a good or service to a given agent. While this may be considered or measured in absolute terms, value may also be considered in relative terms (i.e. the market value for a good or service indicates how much that good or service is considered to be worth, relative to other desired goods or services). Conceptualisations of ‘value’ may also vary depending on the agent(s) in question, for example in relation to ‘public value’ or ‘social value’.

- Public Value: The value created when public money is translated into outputs/outcomes which improve people’s lives and economic well-being. – HM Treasury (2019) Public Value Framework
- Social Value: Social value is the net measure of total welfare resulting from an option or intervention. Alternatively, it is the sum of total benefits and total costs of an intervention, including private and social costs and benefits. – HM Treasury (2020) The Green Book

**Value for Money**: Good value for money is the optimal use of resources to achieve the intended outcomes. ‘Optimal’ means ‘the most desirable possible given expressed or implied restrictions or constraints.’ Value for money is not about achieving the lowest initial price. – National Audit Office (2019)

- Value for Money: ‘Optimising net social costs and benefits. This Public sector assessment of value is based upon the interests of society as a whole and is not an assessment of value to the public sector alone. It is derived according to the methodology of the Green Book.’ – HM Treasury (2013) Value for money and the valuation of public sector assets
- Value for Money: Achieving value for money can be described as using public resources in a way that creates and maximises public value. This ensures that the assessment focuses on the impacts of a proposal that are ‘additional’ (lead to a net increase in overall public value). The value for money is primarily driven by how economical the purchase of inputs is; how

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48 ‘Value for money’ links directly to the Green Book definition of ‘prosperity’: the best value for money option is the one which provides the biggest increase to prosperity for society as a whole.
efficiently those inputs are converted into outputs; and how effectively those outputs achieve outcomes. – *Department for Transport (2017) Value for Money Framework*

- Value for Money: In pursuing policy objectives, the objective of all public sector bodies is to achieve Value for Money (VfM) defined as optimising net social costs and benefits. The assessment of value is based upon the interests of society as a whole rather than to MOD or the public sector alone. VfM can be defined as the optimal combination of economy (i.e. cost of inputs), efficiency (i.e. ratio of output to inputs), effectiveness (i.e. value of outcomes from outputs). VfM can also be expressed as the optimal trade-off between time, cost and effectiveness. – *MOD (2014) Joint Service Publication 507 Pt.1*
## Annex B. A potential logic model for UK defence

<table>
<thead>
<tr>
<th>NSOs</th>
<th>Outcomes</th>
<th>End Outputs</th>
<th>End Activities</th>
<th>Intermediate Outputs</th>
<th>Intermediate Activities</th>
<th>Inputs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protecting Our People</td>
<td></td>
<td>Our people abroad are protected</td>
<td>Provide the nuclear deterrent</td>
<td>Defence Policy</td>
<td>Training (individual &amp; collective)</td>
<td>PS; Economic; Social</td>
</tr>
<tr>
<td>Protect our People</td>
<td></td>
<td>Our people at home are protected</td>
<td>Deter &amp; defence against threats to the UK</td>
<td>Defence Strategy</td>
<td>Equipment</td>
<td>Political</td>
</tr>
<tr>
<td>Protect our People</td>
<td></td>
<td>Our national sovereignty is protected</td>
<td>Deter &amp; defend against threats to UK bases and territories overseas</td>
<td>Defence Strategy</td>
<td>Research &amp; Development</td>
<td>Technical</td>
</tr>
<tr>
<td>Protect our People</td>
<td></td>
<td>UK homeland and overseas territories are secure</td>
<td>Support civil contingency ops and the protection of defence’s CNI</td>
<td>Defence Strategy</td>
<td>Information</td>
<td>Legal</td>
</tr>
<tr>
<td>Protect our People</td>
<td></td>
<td>A wide range of security threats are countered</td>
<td>Hold forces at readiness to conduct CT ops in the UK</td>
<td>Defence Strategy</td>
<td>Organisation</td>
<td>Environmental</td>
</tr>
<tr>
<td>Insuring against an uncertain future</td>
<td></td>
<td>Protecting Our People</td>
<td>Conduct overseas hostage rescure missions</td>
<td>Defence Policy</td>
<td>Cyber capabilities</td>
<td>Logistical</td>
</tr>
<tr>
<td>Insuring against an uncertain future</td>
<td></td>
<td>Protecting Our People</td>
<td>Support the protection of non-defence CNI</td>
<td>Defence Policy</td>
<td>Space capabilities</td>
<td>Infrastructure</td>
</tr>
<tr>
<td>Insuring against an uncertain future</td>
<td></td>
<td>Protecting Our People</td>
<td>Conduct overseas strike operations</td>
<td>Defence Strategy</td>
<td>Joint/Combined capabilities</td>
<td>Acquisition</td>
</tr>
<tr>
<td>Insuring against an uncertain future</td>
<td></td>
<td>Protecting Our People</td>
<td>Conduct major combat operations under NATO Article V</td>
<td>Defence Strategy</td>
<td>Defence Capabilities</td>
<td></td>
</tr>
<tr>
<td>Insuring against an uncertain future</td>
<td></td>
<td>Protecting Our People</td>
<td>Conduct operations to restore peace and stability</td>
<td>Defence Strategy</td>
<td>Defence Capabilities</td>
<td></td>
</tr>
<tr>
<td>Insuring against an uncertain future</td>
<td></td>
<td>Protecting Our People</td>
<td>Conduct non-Article V combat ops</td>
<td>Defence Strategy</td>
<td>Defence Capabilities</td>
<td></td>
</tr>
<tr>
<td>Insuring against an uncertain future</td>
<td></td>
<td>Protecting Our People</td>
<td>Support non-combatant evacuation, humanitarian assistance and disaster relief ops</td>
<td>Defence Policy</td>
<td>Defence Capabilities</td>
<td></td>
</tr>
<tr>
<td>Insuring against an uncertain future</td>
<td></td>
<td>Protecting Our People</td>
<td>Direct the defence enterprise and generate, sustain and enable the force</td>
<td>Defence Policy</td>
<td>Defence Capabilities</td>
<td></td>
</tr>
</tbody>
</table>

- **NSOs:** National Security Objectives
- **Outcomes:** Outputs of the NSOs
- **End Outputs:** Final effects of the outcomes
- **End Activities:** Activities that contribute to the end outputs
- **Intermediate Outputs:** Intermediate effects of the outcomes
- **Intermediate Activities:** Activities that contribute to the intermediate outputs
- **Inputs:** Resources required to achieve the outcomes
Our values are defended and promoted
Key partnerships shape global norms
Soft power is reinforced through hard power levers
Allied and adversary behaviours shaped by the UK
The UK retains a strong voice in global decision-making

Contribute to understanding global security environment through Int and Fwd Presence
Resource NATO staff posts and priority NATO force contributions
Resource core staff posts within the global defence network
Contribute to global defence network and non-NATO posts
Provide force elements for NATO and other reassurance measures
Conduct capacity building with partners & allies

Defence Policy
Defence Strategy
Defence Capabilities
Land capabilities
Air capabilities
Maritime capabilities
Cyber capabilities
Space capabilities
Joint/Combined capabilities

Training
(Individual & collective)
Equipment
Research & Development
Information
Doctrine & Concepts
Organisation
Infrastructure
Logistics
Acquisition

Political
Economic
Social
Technological
Legal
Environmental

Projecting our global influence
Contributing to international security
<table>
<thead>
<tr>
<th>NSOs</th>
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<th>End Outputs</th>
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<th>Intermediate Activities</th>
<th>Inputs</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>The conditions for all trade and industry are secured</td>
<td>Conduct innovative R&amp;D to gain operational advantage</td>
<td>Defence Policy</td>
<td>Defence Strategy</td>
<td>Training (individual &amp; collective)</td>
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<tr>
<td></td>
<td></td>
<td>Opportunities provided in deprived areas</td>
<td>Maximise defence contribution to the wider economy</td>
<td>Defence Strategy</td>
<td>Defence Capabilities</td>
<td>Equipment</td>
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<tr>
<td></td>
<td></td>
<td>Exports and foreign direct investment are promoted</td>
<td>Maximise defence contribution to inward investment</td>
<td>Research &amp; Development</td>
<td>Land capabilities</td>
<td>Economic</td>
</tr>
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<td></td>
<td></td>
<td>Competitiveness in industry is maintained</td>
<td>Promote defence and security exports, and increase global opportunities</td>
<td>Information</td>
<td>Air capabilities</td>
<td>Social</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Our people and skills are invested in</td>
<td>Shape and strengthen the competitiveness of UK defence industry</td>
<td>Doctrine &amp; Concepts</td>
<td>Maritime capabilities</td>
<td>Technological</td>
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<tr>
<td></td>
<td></td>
<td>R&amp;D is driven by Defence, and creates UK IP</td>
<td>Contribute to the fabric of the nation including the Union</td>
<td>Organisation</td>
<td>Cyber capabilities</td>
<td>Legal</td>
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<td></td>
<td></td>
<td>Regions across the UK receive economic benefits</td>
<td></td>
<td>Infrastructure</td>
<td>Space capabilities</td>
<td>Environmental</td>
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<td></td>
<td></td>
<td>Supporting our national economy</td>
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<tr>
<td></td>
<td></td>
<td>Promote our Prosperity</td>
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<td></td>
<td></td>
<td>Contributing to national identity &amp; social welfare</td>
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<td></td>
<td></td>
<td>The shared identity of the UK is supported by Defence</td>
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<td></td>
<td></td>
<td>Ceremonial roles in UK public life are fulfilled</td>
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<td></td>
<td>UK defence supports local communities</td>
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<td></td>
<td></td>
<td>Veterans and military families are fully supported</td>
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<td></td>
<td></td>
<td>Our military heritage is safeguarded</td>
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<tr>
<td></td>
<td></td>
<td>Civic and social integration are promoted</td>
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