An uncertainty based approach to modelling risks using the CBR Risk Model (CRiM)

Stephen Jarrett-Sprague (Dstl), Harriette Taylor (Dstl), Patrick Dooley (DRDC), Chris Pitsaris (DST Group), Matthew Testolin (DST Group)

Chemical, Biological and Radiological Division, Dstl Porton Down, Salisbury, Wiltshire, SP4 0JQ

Summary

- To support the management and mitigation of CBRN risks to deployed military forces, Dstl (UK), DST Group (Australia) and DRDC (Canada) have produced a CBR Risk Model (CRiM) that examines the impact and likelihood associated with a range of CBR vignettes.
- Using Monte Carlo simulation, CRiM determines the likelihood, impact, and risk of CBR events at a Seaport of Disembarkation (SPOD). CRiM has been used to assess 20 vignettes to demonstrate the method, with output presented to senior decision-makers using innovative heatmap visualisations.
- Results have so far shown that each nation holds similar beliefs on CBR likelihood and, despite different in-service capabilities, nations have the same top six impacts and risks.

Approach

Likelihood assessments of 20 vignettes were conducted in each nation using 57 subject matter experts (SMEs) from 3 communities (Intelligence; Science and Technology; and Military). A total of 90 pairwise comparisons were completed by each individual. Data was corrected for consistency and combined to give a likelihood with uncertainty for each vignette.

Impact assessments were made for each vignette. CRiM was used to conduct a Monte Carlo simulation for each vignette over a variety of scenarios giving a range of impacts, from the best case scenario to the worst case scenario. Impact was measured in US $.

Risk assessments were created by combining Impact and likelihood assessments for each vignette. Using rules derived from SME judgement each vignette's probability of operational failure was calculated.
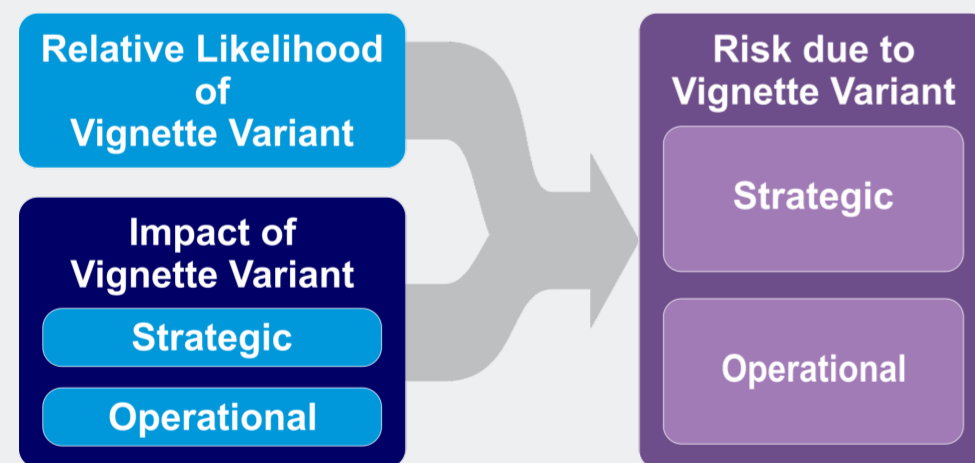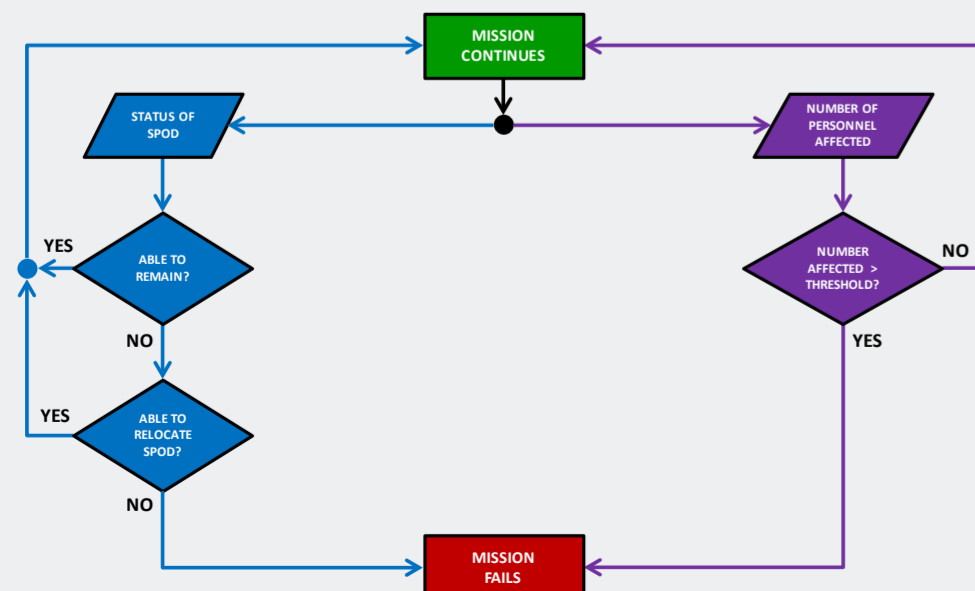

Figure 1: Calculation of risk

Figure 2: Mission failure flow diagram for Seaport of Disembarkation (SPOD)

Data

CRiM uses a representation of current policy, doctrine and operating environments and is able to assess impact of current and future capabilities.

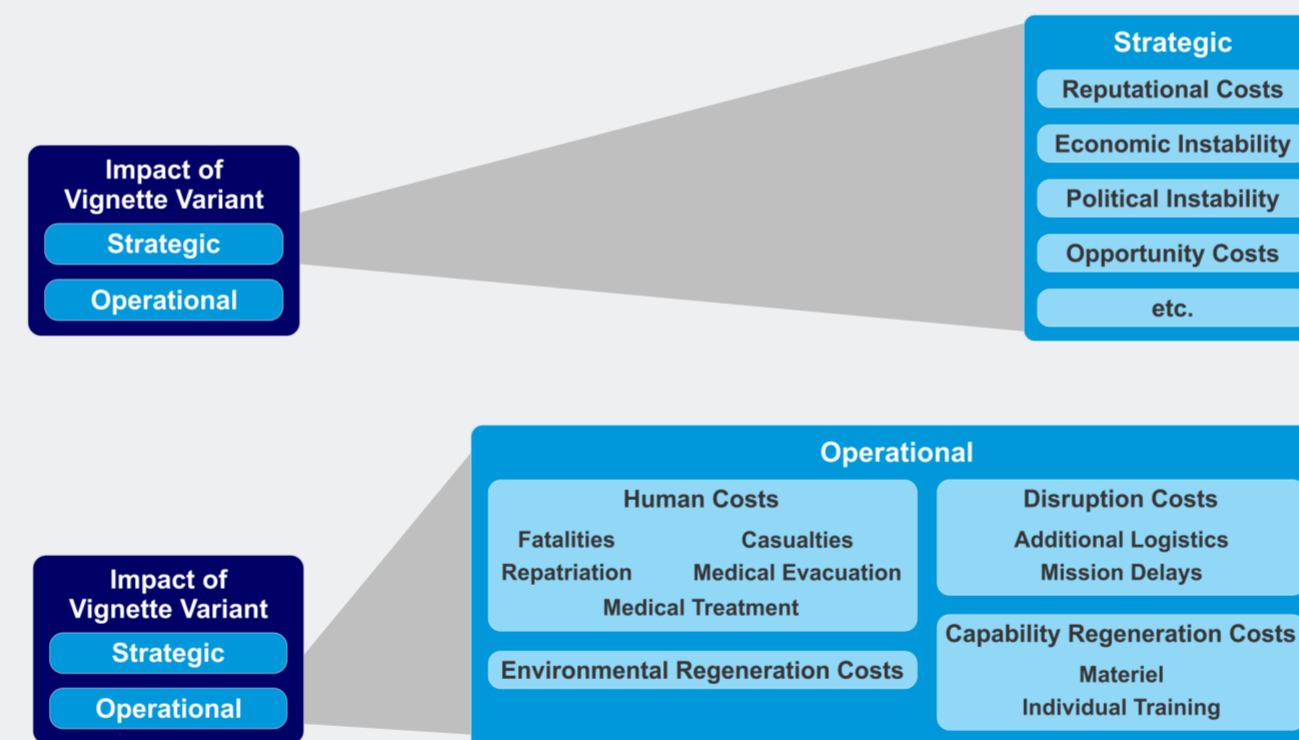Impact is assessed strategically and operationally.

Figure 3: Strategic and operational impact

International Partners

Defence Research and Development Canada
Recherche et développement pour la défense Canada

DRDC | RDDC

Australian Government
Department of Defence
Science and Technology

Results

Each nation holds similar beliefs on CBR likelihood and, despite different in-service capabilities, nations have the same top six impacts and risks.
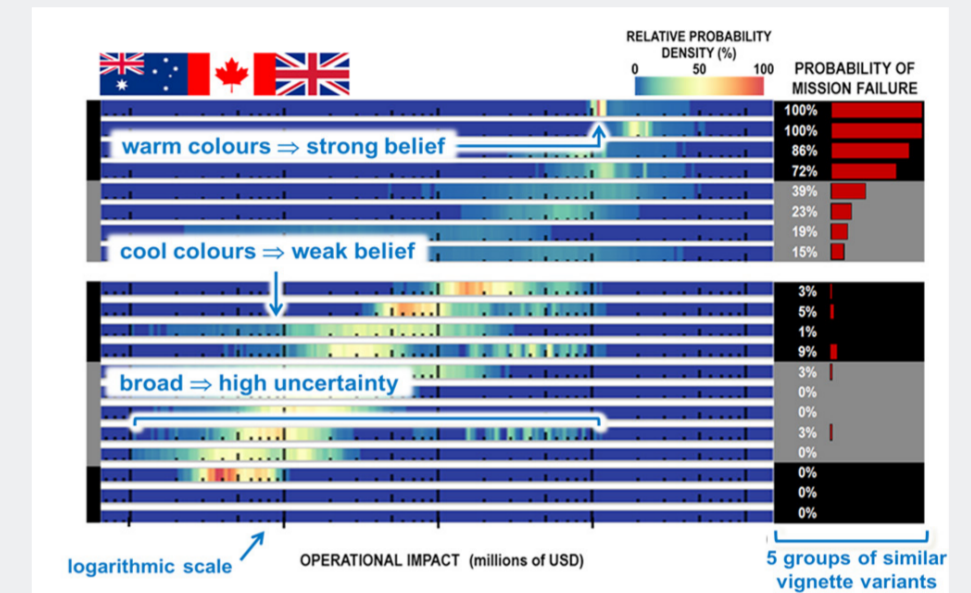

Figure 4: Example heatmap output for risk

The ordering of risk differs to that for impact and likelihood, for example events with a high likelihood may have a low impact, and therefore be a middle order risk.
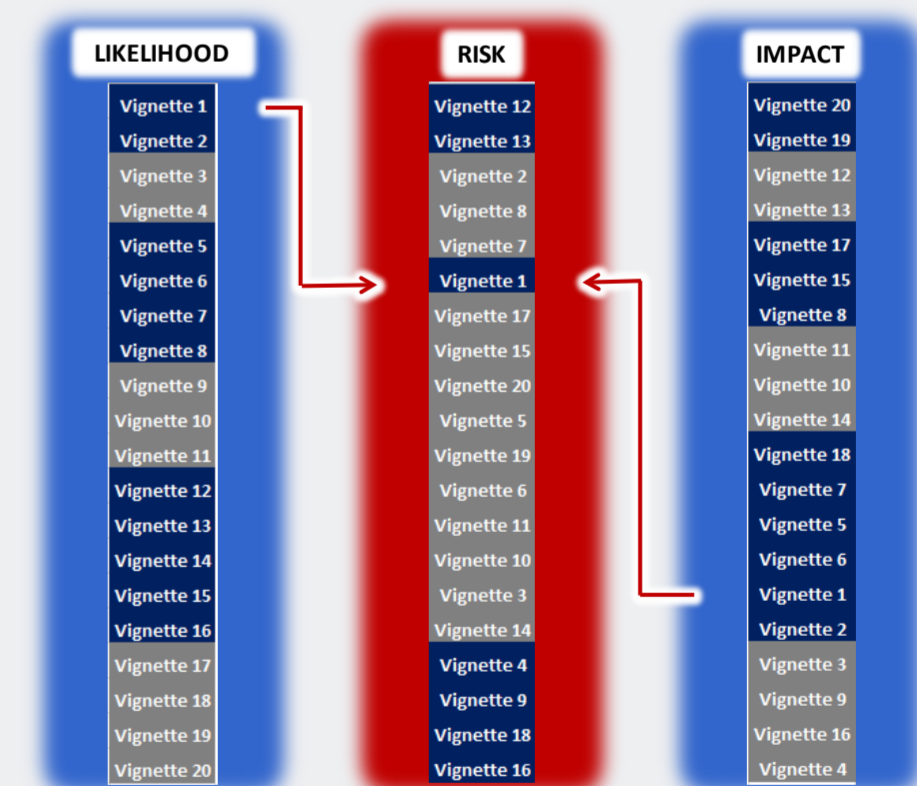

Figure 5: Ordering vignettes by likelihood, impact and risk

Impact and Exploitation

- Developed heatmaps that provide an effective way for decision-makers to visualise uncertainty.
- Produced risk analysis that will be used to support decision-making on capability development and procurement.
- Method will allow comparison of current and future capability
- Methodology is adaptable for other domains.