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On the "Influence of Scenarios to Priorities" in Risk and Security Programs

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1.1 Introduction

Organizations are challenged by an uncertain and evolving future of technological, social, economic, security, and environmental factors, all in the direction of resilient, sustainable, and robust systems. Multiple shared or conflicting aims of various stakeholders, whose individual "stakes" can range from large to small, which change over time, must be taken into consideration in a negotiation of current and future priorities. The science and engineering community has an important role in providing research, methods, and tools to aid in the development of metrics, models, solutions, and methods that prioritize among candidate solutions and procedures for tracking/monitoring of progress. Furthermore, risk analysis has had a role in identifying current and future risk scenarios of which the system might be exposed and understanding the impacts of these scenarios. In a world of varying societal and governance conditions, terrorism, cyber-attacks, extreme weather events, and other "deep" uncertainties without reliable knowledge of probability and severity call for special consideration.

Scenario-based preferences (Connelly et al. 2015; Hamilton et al. 2013; Karvetski and Lambert 2012; Karvetski et al. 2009; Thorisson et al. 2017) are a family of methods that focus on the influence of combinations of different emergent and future conditions, or *scenarios*, on the priorities of an organization such as a government agency, division, or a specific program. The priorities of an organization are for policies, technologies, geographic locations, infrastructure investments, and other *initiatives*. A result of the approach is to quantify the influence of the different scenarios to the prioritization of initiatives, compared to a baseline, and to identify initiatives that are consistently prioritized as high and initiatives that importance is sensitive to different scenarios. Therefore, the approach supports the selection

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of a resilient portfolio of initiatives and helps anticipate potential effects of a changed decision context.

Risk analysis and management practices at an organization should be carefully planned and structured. Many organizations and experts in academia and industry have developed frameworks for performing risk management. Furthermore, some have considered how to guide the establishment of such practices that meet the specific needs of the entity in question while conforming to higher level organizational objectives and missions. This chapter introduces a canonical formulation for developing a *risk program*, the interdependent risk assessment, management, and communication activities within an organizational unit. The formulation takes the form of three questions, each applying to a phase of developing a risk program: scope definition, operational design, and monitoring and evaluation. The chapter describes how risk and security programs address *risk* as the "influence of scenarios to priorities," as proposed by Lambert et al. (2013a, b).

The organization of the chapter is as follows: first, several guidelines for developing risk programs are reviewed, and the canonical formulation is introduced and discussed. Second, the scenario-based preference model is described, and third, the methods are demonstrated through a case study of a risk-centric electric power capacity expansion plan evaluation.

1.2 Risk Programs

The US Department of Homeland Security (DHS) defines the core missions of the organization as (i) preventing terrorism, (ii) securing and managing borders, (iii) enforcing and administering immigration laws, (iv) safeguarding and securing cyberspace, and (v) ensuring resilience to disasters (US Department of Homeland Security 2016). It constitutes agencies, offices, advisory groups, and other components that while serving these core missions have different responsibilities, emphases, and priorities. In the context of risk analysis, this means that different approaches have been developed to serve the needs of the different components. A 2010 report (Committee to Review the Department of Homeland Security's Approach to Risk and Analysis 2010) provides an overview of risk analysis at the DHS. The report identifies a large number of projects, initiatives, standards, assessments, models, frameworks, and more, related to the assessment, management, and communication of risks. Some are independent activities with a specific purpose, while others may be part of a larger-scale risk analysis effort. To be consistent in the description of methodology and to avoid potential confusion, the term risk program will be used in this chapter to encompass many of the aforementioned activities. A *risk program* is here defined as interdependent risk assessment, risk management, and risk communication activities within a program or an organizational component and the coordination of these activities.

Guidelines for risk management exist in both the public and private sectors. They can be specific to a specific organization or domain, while others are intended for a broader audience with more flexibility for customization. A goal of this chapter is to synthesize elements from several guidelines to create a template to assist in the development of a risk program.

The European Union Agency for Network and Information Security provides support and recommendations to member states regarding policy making and implementation of cyber security measures. To promote these activities, the agency has published a large collection of materials on risk management, including inventories of methods and tools, comparability and interoperability issues of risk management methods, and integration of risk management with other operational processes (ENISA 2016a). Especially relevant to risk program guidelines is the "Template of Risk Management – Risk Assessment Methods" (ENISA 2016b), which outlines specifications of a tool supporting comprehensive risk analysis, consistent with our definition of a risk program. The template is in three parts: *Tool identity card*, *Scope*, and *Users viewpoint*. The *Tool identity card* contains general information on the tool, where and when it was developed, what languages it is available in, pricing, and availability. Furthermore, it specifies what risk assessment and management phases are supported, such as risk identification, risk evaluation, and risk communication. A tool can therefore be comprehensive or specific to a certain phase within a risk program. The *Scope* identifies target organizations and geographical spread for the tool, whether it is targeted at the managerial, operational, or technical level of an organization, and compliance with standards. Finally, the *Users viewpoint* section specifies what skills are needed to install, use, and maintain the tool, how the tool is integrated with other organization processes, compatibility with existing databases, and flexibility in customizing.

The NASA Office of Safety and Mission Assurance is responsible for assuring safety and enhancing the success of operations at the agency. The office has developed "Agency Risk Management Procedural Requirements" (NASA 2014). The agency defines risk management in terms of *risk-informed decision making* (RIDM) and *continuous risk management* (CRM). RIDM advocates the consideration of information about risks and uncertainties when choosing among decision alternatives. CRM is then used to manage the risks that emerge from the RIDM process. The requirements specify the responsibilities of (i) the manager of an organizational unit and (ii) the risk manager of the organizational unit. The manager is responsible for higher-level requirements such as appointing a qualified risk manager for the unit, ensuring that risk identification and analysis is used to inform decisions, when issues should be brought to a higher level within the organization, and coordinating with other units on cross-cutting risks. Thus, the risk manager has responsibilities such as ensuring the adequate training of staff and development of a risk management plan.

In the United Kingdom, leading risk management agencies have compiled "A structured approach to Enterprise Risk Management (ERM) and the

requirements of ISO 31000" (AIRMIC et al. 2010). The purpose of the guide is to describe the principles and processes of risk management, provide an overview of the requirements of ISO 31000, give practical guidance on designing a suitable framework, and give practical advice on implementing ERM. The guide describes necessary content of a risk management policy as follows (AIRMIC et al. 2010):

- Risk management and internal control objectives (governance).
- Statement of the attitude of the organization to risk (risk strategy).
- Description of the risk aware culture or control environment.
- Level and nature of risk that is acceptable (risk appetite).
- Risk management organization and arrangements (risk architecture).
- Details of procedures for risk recognition and ranking (risk assessment).
- List of documentation for analyzing and reporting risk (risk protocols).
- Risk mitigation requirements and control mechanisms (risk response).
- Allocation of risk management roles and responsibilities.
- Risk management training topics and priorities.
- Criteria for monitoring and benchmarking of risks.
- Allocation of appropriate resources to risk management.

1.3 Canonical Questions Guiding Development of Risk Programs

There are several commonalities in the three frameworks reviewed above. All emphasize the importance of documentation of requirements, responsibilities of managers and other stakeholders, and operational processes. These factors create the foundations for three canonical questions to guide the development of risk programs for homeland security. Each question has an overarching mission and several subtasks. A risk program, as other engineering activities, is divided into the life-cycle stages of program requirements, program preliminary design, detailed design, program development, and program disposal. However, the risk program considers each stage from a risk-centric point of view (Teng et al. 2012).

1.3.1 Canonical Question I: Scope

What are the sources of risk to be managed, i.e. what is the scope of the program?

- Define the scope of the program.
- Organize the risk program office.
- Set near-term, mid-term, long-term goals.

- Prioritize objectives.
- Review and document.

The first canonical question defines the program scope and specifies responsible officers. The scope can range from narrow to wide, involving risks associated with organizational units, geographic locations, the environment, terrorism, accidents, politics, overrun costs, technical performance, capabilities, and others. Associated with the scope are goals and objectives of the risk program, which is what risks are to be eliminated, mitigated, or accepted and what the relevant time frames are. This question also addresses the organization of the risk program office: assignment of responsibilities to individuals or units and reporting requirements across organizational structures.

1.3.2 Canonical Question II: Operational Design

How should multiple risk assessment, management, and communication activities be coordinated, and what should be the basis for resource allocation?

- Analyze available resources.
- Analyze interdependencies.
- Identify technical approaches for risk identification, assessment, and management.
- Prioritize resource allocation.
- Formulate program plans for operation.

The second canonical question pertains to operational design of the program. Resource allocation, identification and selection of technical approaches, and formulation of operating strategies are the main activities addressed by this question. Especially in public agencies, resources are limited, and initiatives and routine activities must be prioritized to avoid cost overruns. Technical approaches for identification, assessment, response, and management of risk are abundant, and methods that are appropriate in terms of detail and cost should be analyzed in the development of a risk program. Interdependencies among units can be taken advantage of when implementing processes that are applicable to many parts of an organization and can save resources. However, as parts become more interconnected, it is important to consider how stress on one unit could cascade through the program. This all feeds into the formulation of program operation plans that specify what approaches should be used and what resources are involved with each of them.

1.3.3 Canonical Question III: Evaluation

How will the performance of the risk program be evaluated and monitored?

- Organize program evaluation team.

- Set performance measures.
- Define measurement methods for data collection.
- Analyze data and compare results.
- Modify risk program policy if needed.
- Manage knowledge and experiences.

The third canonical question addresses the continuous evaluation and monitoring of the program, beyond what is specified in the program operation plans. This includes establishing an evaluation team, which can consist of individuals from within the organization as well as outside experts. Performance measures or success criteria should be established in order to allow for comparison between programs and tracking performance of individual programs over time. The evaluation team must define what data is collected and how and what analyses are to be required to measure program performance. When shortcomings in current processes or better practices are found, it may be necessary to modify the risk program policy, and communication channels between management and the evaluation team must be effective in order for the evaluation phase to achieve its purpose.

1.4 Scenario-Based Preferences

Traditional risk analysis focusing on the probability and severity of adverse effects has a critical role in the analysis of socio-security systems. However, when systems are complex and involve multiple stakeholders and various uncertain factors, known and unknown, attempting to identify a complete set of all possible future possibilities and assigning probabilities presents challenges and can fall short to address macroscale disruptions in security, demographics, politics, environment, and others. Integrating qualitative methods such as risk identification using hierarchical holographic modeling (Haimes 2015; Lambert et al. 2001) and scenario planning with multi-criteria analysis promotes and supports robust strategic decision making (Montibeller and Franco 2010).

Multi-criteria analysis helps decision makers to structure problems and make traceable, justifiable, and explainable decisions (Belton and Stewart 2002; Chankong and Haimes 1983; Linkov et al. 2006). Integrating scenarios with multi-criteria analysis has been used to support robust strategic decision making for systems (Montibeller and Franco 2010). In contrast to traditional risk analysis focusing on probabilities and consequences, multi-criteria analysis *with scenario-based preferences* has focused on *risk* as the *influence of scenarios on priorities* (Karvetski and Lambert 2012; Thekdi and Lambert 2014). Scenario planning can be useful in exploring uncertainties of complex systems where likelihoods are derived from expert opinions and subject to

cognitive bias (Goodwin and Wright 2001). The scenarios are uncertainties of military conflict, terrorism, natural disasters, politics, economics, environment, behaviors, and society. They can be directly advocated or brought about by actions of particular stakeholder, such as violating terms of contracts and attacking critical infrastructure, while others may be less under the influence of stakeholders, such as natural disasters and industrial accidents.

The following section describes the scenario-based preference model. The method has previously been applied to energy security (Hamilton et al. 2013; Karvetski et al. 2011a, b), disaster management (Lambert et al. 2013a, b; Parlak et al. 2012), development of a biofuel industry (Connelly et al. 2015), and impacts of climate change to infrastructure investment (Hamilton et al. 2015; Karvetski et al. 2011a, b; You et al. 2014a).

1.5 Methodology

An aim of the methodology is to measure the influence of scenarios to the prioritization of initiatives and evaluate the robustness of individual initiatives to scenarios. Intermediate outputs are several prioritizations, different for each scenario.

Initiatives are projects and project elements, both planned and proposed, that compete for resources and funding. Due to limited resources the initiatives must be prioritized or classified such that comparison in terms of how well initiatives meet *success criteria* is possible. Success criteria represent goals and objectives of different stakeholders of the system. Emergent and future conditions are factors, both internal and external, that may influence the prioritization of initiatives by posing danger to the system or exploiting vulnerabilities. *Scenarios* are emergent and future conditions, alone and in combination, that represent a specific future or development of the system.

The scenario-based preference model builds upon traditional multi-criteria analysis by adding multiple scenarios in which initiatives may perform differently and preferences may shift (Collier et al. 2016). Scenarios are composed of one or more emergent conditions, such that various combinations of conditions can be assembled to represent a variety of future scenarios. The mathematical foundations of the scenario-based preference model are described (Hamilton et al. 2015; Karvetski et al. 2009, 2011a, b; Thorisson et al. 2017) and are briefly outlined here.

Let $S_c = \{c_1, \ldots, c_m\}$ be the set of m success criteria and $S_x = \{x_1, \ldots, x_n\}$ be the set of n initiatives. Through observation, expert elicitation, or other means, initiatives are scored by their coverage of criteria. Thus, an $n \times m$ decision matrix can subsequently be constructed, where each cell x_{ij} is the score that initiative x_i receives for criterion c_j.

To add the scenario component, let $S_{ec} = \{ec_1, \ldots, ec_p\}$ be the set of p emergent conditions that form the elements of a scenario. An emergent condition could be a stakeholder belief or value, future event, or a trend that affects decision making (Karvetski et al. 2009). Examples from the domain of national and international security are attacks on critical infrastructure, budget cuts for agencies, natural disasters, shifts in government policies, etc. Let $S_s = \{s_1, \ldots, s_q\}$ be the set of q scenarios, which consist of one or more emergent conditions, e.g. s_1 could be a scenario where disaster management agencies are underfunded and a natural disaster occurs simultaneously.

The weight for criterion c_j in scenario s_k, defined as w_{jk}, represents the trade-off coefficient of that criterion under scenario s_k. Criteria weights may be held consistent across scenarios, but scenario-dependent weighting can also be conducted as preferences are assumed to change given different scenario-specific objectives (Durbach and Stewart 2006, 2012; Goodwin and Wright 2001; Ram et al. 2011). For demonstration of the concept, a linear additive value function that assigns a value to alternative x_i under scenario s_k is defined as

$$V(x_i)_k = \sum_{j=1,m} w_{jk} x_{ij} \tag{1.1}$$

The initiative with the greatest aggregated value $V(x_i)_k$ in each scenario is considered to have the highest priority in that scenario. Thus the initiatives are ranked from high priority to low priority in each scenario-based on their values $V(x_i)_k$. The notation used for the rank of initiative x_i in scenario s_k is r_{ik}.

Initiatives having high priority in a multitude of scenarios are considered robust, while initiatives that priority varies from high to low across scenarios are considered sensitive to emergent and future conditions. Several metrics for robustness are discussed by Roy (2010). First, *absolute robustness* is measured by the ranking of the initiative in the worst scenario. The most robust initiative according to this metric is the one with the highest minimum ranking. Second, *absolute deviation* is measured by the maximum change in ranking from the baseline to a scenario. The most robust initiative is the one with the lowest change in ranking. Third, robustness is defined by a threshold, set by the decision maker, which must be exceeded for an initiative to be considered robust. For example, initiatives ranked in the top five in all scenarios are considered robust.

Another result of the method is the influence of different scenarios to the prioritization, which can be measured in several ways. To generalize the idea, an influence function for scenario k is defined as a function of the prioritizations for the baseline scenario s_0 and scenario s_k. The influence function can take many forms. In a simple case, the sum of rank changes can be used as a basis (Connelly et al. 2015). A scenario is considered more influential if multiple initiatives have different priority when subjected to that particular

scenario compared to the baseline. The influence function is then the average rank transition a scenario causes; n is the number of initiatives:

$$I_1(S_k) = \frac{\sum_{j=1,n} |r_{jk} - r_{j0}|}{n} \tag{1.2}$$

Depending on the preferences of stakeholders, the effects of large changes in ranks might be more important than smaller changes, and the sum of squares of rank changes better reflects these preferences:

$$I_2(S_k) = \frac{\sum_{j=1,n} (r_{jk} - r_{j0})^2}{n} \tag{1.3}$$

Further influence metrics include methods based on rank correlation techniques such as Spearman rank correlation coefficient (Thorisson et al. 2017) and Kendall Tau-b distance (You et al. 2014a, b). These are statistical measures of correlations between two samples of ordinal data. Possible values range from 1 (total positive correlation) to 0 (no correlation) to −1 (total negative correlation). The Spearman rank correlation coefficient is defined as

$$I_3(s_k) = 1 - \frac{6 \sum_{j=1}^{n} (r_{jk} - r_{j0})^2}{n(n^2 - 1)} \tag{1.4}$$

To define the Kendall Tau-b distance, it is necessary to define concordant, tied, and discordant pairs of ranking values. In the ranking of a pair of initiatives, x_i and x_j, it is said to be concordant if both $r_{ik} > r_{i0}$ and $r_{jk} > r_{j0}$ or both $r_{ik} < r_{i0}$ and $r_{jk} < r_{j0}$. They are tied if $r_{ik} = r_{i0}$ or $r_{jk} = r_{j0}$ and discordant otherwise. Let m_{ck} be the number of concordance rankings, m_{dk} be the number of discordant rankings, and t_k be the number of rankings tied in scenario s_k. Then the Kendall Tau-b correlation is defined as

$$I(s_k) = \frac{1}{2} \left[1 - \frac{m_{ck} - m_{dk}}{\sqrt{(m_{ck} + m_{dk} + t_0)(m_{ck} + m_{dk} + t_k)}} \right] \tag{1.5}$$

The evaluation of influence functions is central to filtering risk scenarios for further consideration as it assesses the potential of scenarios to change the minds of decision makers. This is an essential property, since a decision process does not benefit much from risk analysis if decision makers have no intention of changing their minds or taking action after new information is revealed.

In the next phase, initiatives are examined in further detail, using appropriate modeling approaches. These are dependent on the nature of the initiatives, and can be qualitative or quantitative, such as cost–benefit analysis, critical path analysis, optimization, and others. Robust initiatives are an attractive investment in multiple scenarios. The reasons behind the sensitivity of other initiatives can also be an important analysis. Extending the approach to multiple time frames (Hamilton et al. 2015, 2016), the results from the detailed

investigation feeds back into reevaluation of initiatives, criteria, and scenarios, thus creating an iterative approach that can be revisited as needed throughout the system life cycle.

1.6 Demonstration of Methods

This section describes a case study where scenario-based preferences are used to prioritize initiatives that advance the power sector in Afghanistan and how various uncertainties of security, politics, economics, institutions, social behavior, etc. influence the priority settings. Decades of conflict have contributed to a drastically underdeveloped infrastructure system in the country. Only 28% of the population had access to reliable electricity in 2014 (United States Agency for International Development 2014) with the power grid divided into several unconnected islands and in some cases operating on different frequencies (Fichtner GmbH & Co. KG 2013). A major objective of agencies supporting infrastructure development in Afghanistan has been to connect the islands and ensure compatibility across the system as well as with the electric grids of the neighboring countries that supply the country with about 70% of its electricity (Fichtner GmbH & Co. KG 2013). Establishing a national interconnected power grid would increase energy security by adding redundancy to the system. Moreover, resources such as the Sheberghan natural gas fields in the somewhat remote northwestern part of the country could provide energy to the more heavily populated regions around the national capital, Kabul. However, volatility in the political, economic, and security landscape is discouraging to potential donors, and planned projects are often delayed or abandoned altogether. With an uncertain security situation and underdeveloped public infrastructure, projects that couple military and civilian needs are particularly attractive to donors and investors. For example, various government ministries as well as military and law enforcement facilities operated by the Afghan National Defense Security Forces (ANDSF) are currently powered by on-site diesel generators. Operating and maintaining the generator systems are expensive, and concerns have been raised about corruption in the diesel fuel supply chain. Connecting aforementioned facilities to the power grid could create substantial savings, allowing surplus funding to be allocated to other infrastructure investments currently underfunded. However, with frequent load shedding and unplanned blackouts, the available capacity and reliability of the current system does not meet the minimum requirements of the government agencies. Western entities like NATO and the US Department of Defense that provide much of ANDSF's funding have recognized the potential of supporting an integrated national power grid, which would service both defense facilities and civilian demand.

To meet these dual needs, a power delivery and power purchase agreement was proposed to the ministries responsible for the Afghan security forces, the national utility company Da Afghanistan Breshna Sherkat (DABS), the Asian Development Bank (ADB), and the US Agency for International Development (USAID) to be externally funded by NATO member states through the Combined Security Transition Command – Afghanistan (CSTC-A). The objective of the agreement is to provide the ministries with reliable electric power while simultaneously benefiting the public by expanding the national power grid. Under the agreement the ministries pay the utility company an above-market rate for electricity while still saving costs compared with powering facilities with diesel generators. The utility company agrees to use the surplus income to integrate ministry facilities into the grid with external funding used to support higher level grid enhancement projects. In order to minimize the possibility of development aid being wasted or abused, risk identification and analysis must be performed, and mitigation strategies developed.

Following the mechanisms described in Section 1.3, several dozen emergent and future conditions – sources of risk and uncertainty that stress the system – are identified. These range from natural factors (e.g. earthquakes and floods) to social (e.g. refugee immigration), economic (e.g. corruption, raw materials shortage), political (e.g. corruption, power imports cut due to regional disputes), organizational (e.g. lack of agency coordination), and security factors (e.g. insurgency damage). The conditions, alone and in combination, are used as the basis for constructing scenarios. The scenarios are constructed with the aim to address a wide range of possibilities. They are inspired by the multiple perspectives of stakeholders of the agreement, including agencies responsible for construction and operations, local and foreign governments, development agencies, the security forces, and the civilian population. Tables 1.1–1.6 describe the scenarios.

Table 1.1 Summary of definition and properties of scenario s_1: insufficient power supply.

Scenario
s_1: Insufficient power supply
Description
ANDSF does not receive the agreed amount of electric power
Key stakeholders/perspective
Construction and operations (DABS and ADB)
Stressors
ec_{12}: Power not provided by DABS
ec_{13}: ADB does not build necessary infrastructure
Influences
Calls for acceleration of large-scale infrastructure investments that either support electricity generation or import. Fines may be imposed on the utility company.

Table 1.2 Summary of definition and properties of scenario s_2: unsatisfactory local governance.

Scenario
s_2: Unsatisfactory local governance
Description
The implementation of the PDPPA meets significant obstacles in the Afghan administrative system
Key stakeholders/perspective
Afghanistan national government
Stressors
ec_3: Widespread corruption in Afghan society and government entities
ec_4: Afghan reluctance or inability to impose accountability, especially on the wealthy or well-connected in government and society
ec_{23}: Lack of agency coordination
Influences
Initiatives are delayed, funds are wasted, and trust of the international donor community decreases

Table 1.3 Summary of definition and properties of scenario s_3: deteriorating security conditions.

Scenario
s_3: Deteriorating security conditions
Description
Insurgency hinders the construction, operation, and maintenance of critical parts of the power grid
Key stakeholders/perspective
Afghan National Defense Security Forces (ANDSF)
Stressors
ec_2: Operational demands and constraints imposed by an active insurgency
Influences
Army and police have to activate backup diesel generators with associated costs, and the public receives less power

A total of 36 planned initiatives (Asian Development Bank 2015; Fichtner GmbH & Co. KG 2013; United States Agency for International Development n.d.) are prioritized under a baseline scenario and for the six scenarios resulting from the risk filtering process. The initiatives include building or restoring of hydroelectric power plants, gas-fired power plants, transmission lines,

Table 1.4 Summary of definition and properties of scenario s_4: public perception problems.

Scenario
s_4: Public perception problems
Description
Significant public resistance to the connection of ANDSF facilities to the power grid
Key stakeholders/perspective
The civilian population of Afghanistan
Stressors
ec_{16}: Public perceives ANDSF as consuming their electrical capacity
ec_{19}: Electricity subsidies terminated
Influences
The public gets subsidized electricity. If subsidies are terminated or decreased, or the availability is otherwise impacted, the general population may lose trust in the ANDSF

Table 1.5 Summary of definition and properties of scenario s_5: electricity imports disrupted.

Scenario
s_5: Electricity imports disrupted
Description
Less availability of electricity increases competition about local energy
Key stakeholders/perspective
Neighboring countries
Stressors
ec_{17}: Disruption of electricity import
Influences
Calls for strengthening regional ties and integration of Afghanistan in the regional economy and politics in order to make reliable agreements with neighboring countries on electricity imports

substations, purchase of operations and maintenance equipment, and project management and implementation plans. A full list of initiatives can be found in Thorisson et al. (2017). Criteria against which initiatives are scored are derived from the Afghanistan National Development Strategy and include *Security and governance*, *Infrastructure and transportation*, *Regional cooperation*, and others as described in Table 1.7 (Islamic Republic of Afghanistan 2008). The criteria cover all three pillars of the strategy such as security, governance, and economic and social development and thus support a holistic and systemic view of the problem.

Table 1.6 Summary of definition and properties of scenario s_6: international management and oversight lacking.

Scenario

s_6: International management and oversight lacking

Description

The United States and other international agencies fail to efficiently manage and oversee development programs

Key stakeholders/perspective

The international development community

Stressors

ec_5: Poor record keeping and data retention by US agencies and Afghan entities

ec_6: Frequent personnel turnover and loss of US agencies in country institutional memory

ec_7: US oversight personnel's noncompliance with existing rules and regulations

Influences

Funds are wasted and infrastructure construction may be delayed. Effort has to be put in strengthening the capacity of the agencies

Table 1.7 Success criteria derived from the Afghanistan National Development Strategy.

Index	Criteria
c_1	Security and governance
c_2	Infrastructure and transportation
c_3	Education, culture, health, agriculture, rural development, social protection
c_4	Economic governance and private sector development
c_5	Capacity building
c_6	Regional cooperation
c_7	Environment
c_8	Gender equality, counter-narcotics, anti-corruption

The prioritization of initiatives is based on value scores that are derived from assessments of the coverage of initiatives of criteria. The assessments are based on interviews and teleconferences with stakeholders and review of planning documentation related to the initiatives. Table 1.8 shows the coverage assessments for a sample of initiatives.

To calculate the value score for each initiative, the coverage assessments must be quantified and weights assigned to the criteria. A full circle, *significant coverage*, is given the value of 1, and a hollow circle, *marginal coverage*, is given the value of 0.5. In the baseline scenario all criteria are given equal weight. In the remaining scenarios, some criteria are given a higher weight according to

Table 1.8 Assessment of impacts of initiatives on success criteria.

		c_1	c_2	c_3	c_4	c_5	c_6	c_7	c_8
x_1	Sheberghan gas development	—	●	—	○	—	—	○	—
x_2	Arghundy to Kandahar transmission line	○	●	○	○	—	—	—	—
x_3	Salang Tunnel substation	—	○	—	—	—	—	—	—
x_4	Kabul power system rehabilitation	○	●	—	○	—	—	—	—
x_5	Kajaki Dam Unit 2	○	●	○	—	—	—	○	—
x_6	CASA-1000	—	●	—	—	—	●	—	—
x_7	TUTAP Kabul to PAK transmission line	—	●	—	—	—	●	—	—
x_8	TKM interconnection	○	●	—	—	—	●	—	—
x_9	Kunduz-Taloqan transmission line	●	○	—	—	—	—	—	—
x_{10}	Baghlan and Kunduz distribution networks	●	○	—	—	—	—	—	—
x_{11}	NEPS O&M emergency equipment	○	○	—	—	○	—	—	—
x_{12}	Rehabilitation of Sheberghan gas wells	—	○	—	—	—	—	○	—
	. . .	—	—	—	—	—	—	—	—
x_{36}	N-S power transmission project implementation and supervision	—	●	—	○	●	—	—	—

●, significant coverage; ○, marginal coverage.

Table 1.9, and the weight remaining criteria are scaled down. To illustrate, for scenario s_5*: Electricity imports disrupted*, the criterion c_6*: Regional cooperation* is given a higher weight since in the case that electricity imports are halted due to shifted priorities or tension in the neighboring countries, initiatives supporting regional cooperation might be more critical to the success of building a reliable power system.

Varying the weights across scenarios results in a different prioritization for each scenario. Comparing the ranking of initiatives gives an indication of their robustness. Figure 1.1 illustrates the results of the prioritization. Each vertical bar represents an initiative, the diamond represents the baseline ranking, and the whiskers represent the range of ranking across scenarios. Of highly ranked initiatives, x_2*: Arghundy to Kandahar transmission line*, x_{15}*: NEPS O&M MTA contract*, and x_{36}*: N-S power transmission project implementation and*

Table 1.9 Criteria given higher weight under different scenarios.

Scenario	Criteria
s_1: Insufficient power supply	c_2: Infrastructure and transportation
s_2: Unsatisfactory local governance	c_5: Capacity building
	c_8: Gender equality, counter-narcotics, anti-corruption
s_3: Deteriorating security conditions	c_1: Security and governance
s_4: Public perception problems	c_4: Economic governance and private sector development
s_5: Electricity imports disrupted	c_6: Regional cooperation
s_6: International management and oversight lacking	c_1: Security and governance
	c_5: Capacity building

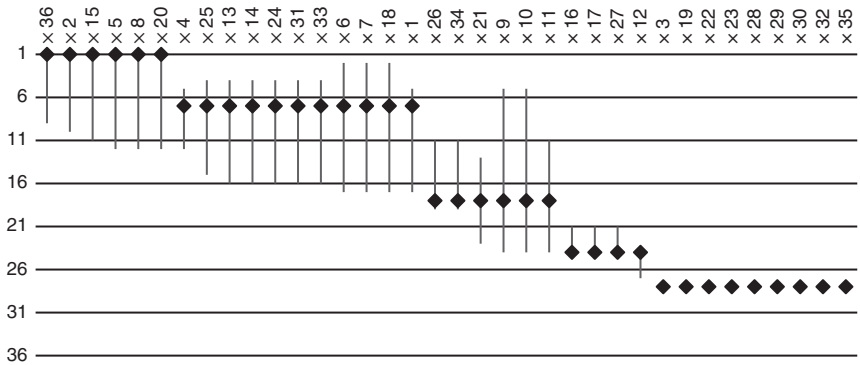

Figure 1.1 Prioritization of initiatives under different scenarios.

supervision are the most robust, each being ranked first in a scenario and always remaining in the top 11.

Measuring the influence of scenarios to priorities, all four metrics are used and compared. Table 1.10 illustrates the influence. There is a good agreement between the metrics; the only difference is that *s_2: Unsatisfactory local governance* and *s_4: Public perception problems* switch positions using I_1 (mean absolute difference). For all metrics, *s_3: Deteriorating security conditions* is the most influential, followed by *s_1: Insufficient power supply*, while *s_5: Electricity imports disrupted* is the least influential.

The results from the scenario-based preferences serve as starting point of discussion for the development of risk management strategies and provide stakeholders with a tool to see how their value statements are expressed in

Table 1.10 Influence of scenarios to priorities.

	I_1	I_2	I_3	I_4
Insufficient power supply	3.42	23.53	0.91	0.81
Unsatisfactory local governance	2.33	12.56	0.95	0.89
Deteriorating security conditions	3.78	30.22	0.85	0.74
Public perception problems	2.22	17.11	0.93	0.86
Electricity imports disrupted	1.58	5.86	0.96	0.91
International management and oversight lacking	3.14	22.31	0.92	0.84

The rank order of the influence among scenarios is in parenthesis. Note that for I_3 (Spearman rank correlation) and I_4 (Kendall Tau correlation), a low value indicates a high degree of influence (low correlation between rankings).

the selection and weighting of criteria and assessments of how well initiatives address those criteria. An important aspect of the analysis is recognizing that the results are not static over time and should be iterated both as internal values of progress of stakeholders and external factors in society change. The goal of the analysis performed is to support a resilient strategic plan in terms of a power purchase and delivery agreement for a systemic solution. Effective risk management strategies are essential in order to mitigate adverse consequences and ensure facilities have reliable access to electricity. The six scenarios coming to the front in the analysis are broadly speaking of organizational/institutional (unsatisfactory local governance, public perception problems, international management, and oversight lacking) or security (deteriorating security conditions) nature, and the remaining two (insufficient power supply and electricity imports disrupted) can derive from or be caused by the occurrence of some of the others. Risk management strategies to mitigate organizational risks include improved oversight by funding agencies over implementing agencies, increasing requirements of reporting and auditing, and creating incentives for officials to reject bribes and other forms of corruption. Mitigating vulnerabilities of facilities to security threats can be achieved without increasing physical protection of assets by building multiple paths of access between facilities and the power grid, installing on-site backup power in form of renewables or continuing maintenance of diesel generators, and implementing conservation measures in terms of insulations, and more efficient light bulbs.

The establishment of criteria sets, construction of scenarios, assessments of initiative coverage of criteria, and selecting an appropriate list of initiatives are important parts in the execution of the methodology presented in this chapter. These are subjective in nature and should include extensive expert and stakeholder engagement. For the case study presented, weekly discussions were held over a five-month period with representatives of the USAID, the

CSTC-A, and the US Army Corps of Engineers (USACE). Furthermore, during the period experts from the Asian Development Bank, the Afghan national utility company, DABS, and the Afghan ministries of interior and defense provided feedback and revisions. Even so, the inputs to the model are subjective to the opinions of the experts and stakeholders that contributed. This subjectivity not only can be seen as a limitation of the methodology but can also be seen to be in line with the philosophy of different scenarios representing different stakeholders and scenarios potentially being advocated by particular groups.

1.7 Discussion and Conclusions

Scenario-based preferences can be viewed as a complement to traditional risk analysis by identifying the scenarios that are most in need of further investigation, including risk analysis, simulation, experimentation, data collection and analysis, etc. The aim is not decision making, but rather to triage what issues are potentially important, via construction of a prototype of a decision-making process. The scenarios are then introduced to quantify the separation between the timeline of priorities in the baseline scenario and the adjusted timeline when the system is subject to a particular scenario. The method addresses the degree of influence of a timeline of priorities, relative to an as-planned timeline. Figure 1.2–1.2 illustrates this view; this visualization is inspired by, though not a direct extension of, the work of Kaplan (1997). Figure 1.2 shows the baseline scenario, s_0, in the space of milestones or implementation timeline of the initiatives. Figure 1.2 and c illustrates how the timeline is influenced by scenarios and recovers and achieves the planned end state (Figure 1.2) or adjusts to a new end state (Figure 1.2). The closeness of the influenced timelines to the as-planned timeline is an illustration of the influence potential of the respective scenario.

The extensive involvement of stakeholders as described previously supports and motivates the emphasis on quantifying influence in the regime of priorities and mind-sets, rather than just in physical structures. This characteristic is shared by some of the events that in recent years have most dramatically impacted the world. The 9/11 attacks on New York and Washington, DC, in 2001 raised the importance of security for many offices and agencies and sparked the establishment of a new US federal agency, the DHS. Along the same lines, the economic recession in 2008–2009 raised the importance of fiscal responsibility, and Hurricane Katrina in 2005 raised the importance of serving underrepresented social groups in disasters. This helps justifying why scenarios influence a change in the relative priority ordering of initiatives, rather than how the scenarios might directly impact the execution of the individual initiatives. The usefulness of the methods and results presented in this chapter should be considered in the context of negotiations or development

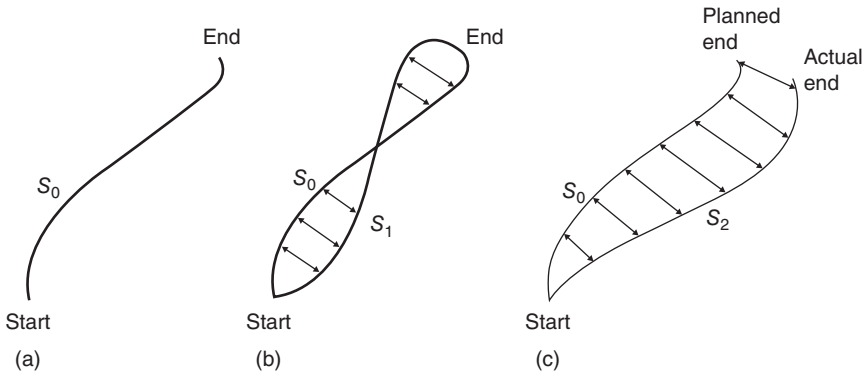

Figure 1.2 Illustration of the influence of scenarios to a timeline of priorities. The method demonstrated characterizes the separation of the timeline from an as-planned timeline when subjected to scenarios.

of terms for risk programs and other strategic plans. By considering multiple perspectives and quantifying how different scenarios might affect a timeline of priorities, the analysis quantifies which scenarios have the most potential to cause a change of mind among stakeholders, which can also be interpreted as which scenarios might prompt renegotiations.

This chapter discusses two main topics, the canonical formulation of risk programs and scenario-based preferences. Both support the establishment of good risk management practices. The canonical questions aim to support the five key principles outlined in DHS Risk Management Fundamentals (US Department of Homeland Security 2011): unity of effort, transparency, adaptability, practicality, and customization. When developing risk programs for homeland security, these principles should be kept in mind during the entire development process. Furthermore, in the conclusions of the DHS risk analysis review (Committee to Review the Department of Homeland Security's Approach to Risk and Analysis 2010) strengthening documentation, validation and peer review of risk analysis practices is one of the main recommendations. This is specifically addressed in the formulation by including a full evaluation phase, including outside experts on evaluation teams, and concluding each phase of the development with documentation of efforts. In terms of national security, scenario-based preferences provide a structured approach to exploring the effects of different scenarios on preferences among alternative policies, preventive and responsive security measures, and others. Considering success criteria, initiatives necessary to achieve an envisioned state and what scenarios might prompt a reevaluation of priorities contribute to a deeper understanding of the core values driving homeland security policies and activities. This in turn supports overall robust decision making and building a resilient society.

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