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SPACES MERL
SYSTEMS AND COMPLEXITY WHITE PAPER

MARCH 2016

This publication was produced for review by the United States Agency for International Development. It was prepared as a collaboration between the Global Obesity Prevention Center (GOPC) at Johns Hopkins, Global Knowledge Initiative (GKI), LINC and ResilientAfrica Network (RAN).

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This research was produced for review by the United States Agency for International Development under agreement no. AID-OAA-A-15-00064.

This paper was prepared by: Global Obesity Prevention Center (GOPC) at Johns Hopkins
Dr. Bruce Y. Lee
Dr. Shawn T. Brown
Marie Ferguson
Daniel Hertenstein
Leila Haidari
Patrick Wedlock
Sarah Bartsch
Global Knowledge Initiative (GKI)
Sara Farley
Kathryn Bowman
LINC
Patrick Sommerville
Rich Fromer
ResilientAfrica Network (RAN)
Dr. Roy William Mayega
Dr. Harriet Namata
Christine Muhumuza
Grace Mongo Bua
Nathan Tumuhamye
Charity Kyomugisha
Professor William Bazeyo

Consortium Contacts:

Dr. Bruce Lee
brucelee@jhu.edu

Patrick Sommerville
psommerville@linclocal.org

Sara Farley
sara@gkinitiative.org

Roy Mayega
rmayega@ranlab.org

DISCLAIMER

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1. INTRODUCTION AND BACKGROUND

The Strategic Program for Analyzing Complexity and Evaluating Systems (SPACES MERL) project is an activity funded by USAID's Global Development Lab and the Bureau for Policy, Planning and Learning (PPL). This three-year activity aims to bring a variety of tools and methodologies that decision-makers can use (alone or in combination) to provide comprehensive systems analysis. The activity is being implemented from 2015 to 2018 by a consortium of organizations expert in systems and complexity, including the Global Obesity Prevention Center (GOPC) at Johns Hopkins University (Prime), Global Knowledge Initiative (GKI), LINC and ResilientAfrica Network (RAN).

This Systems and Complexity White Paper is a collaborative effort of the SPACES MERL team, designed to frame the international development landscape, with particular reference to USAID-funded activities, for application of systems and complexity approaches to design, monitoring and evaluation. Customized to the systems and complexity layperson with in-depth knowledge of international development practice, the objectives of this white paper are three-fold:

- Provide an overview of systems and complexity practice, its current state of application and relevance to international development practice;
- Establish a taxonomy of systems and complexity tools, highlighting the fit of those offered by SPACES MERL within the wider landscape; and
- Review and provide information on application of SPACES MERL tools, their purpose and construction, required data, and their applicability to specific contexts.

This paper is partially based on interviews with numerous experts in USAID from various Bureaus (including the US Global Development Lab; the Bureau for Policy, Planning and Learning; the Bureau for Global Health; the Bureau for Democracy, Conflict and Humanitarian Assistance; the Bureau for Food Security; the Bureau for Middle East; and the Bureau for Economic Growth, Education, and the Environment) as well as missions (including Uganda). Some of the tools described might not necessarily be strictly speaking "complex systems" tools, but were still identified and suggested as such. The paper does not attempt to capture the universe of existing complex tools, but aims to represent examples within categories.

In addition to producing this white paper, we aspire to identify and develop pilot use cases for application of SPACES MERL's systems and complexity tools. On the basis of this combined research and piloting from 2016 to 2018, the SPACES MERL activity will culminate with the development of a systems and complexity toolkit for reference and application by international development practitioners, both within and beyond USAID. The toolkit will be enriched by a series of use cases and insights derived from our research and piloting activities. Beyond enabling USAID decision makers to effectively and accurately utilize the different tools within the SPACES MERL Toolkit, the consortium aims to cultivate a broader appreciation of the many ways in which complex systems analysis and understanding can deliver long-term benefits through systems mapping and modeling; early-detection of successes and failures; and future-oriented innovation impact assessment.

2. WHAT IS A COMPLEX SYSTEM?

The international development landscape is a complex place. Actors are prone to unpredictable behavior, are governed by ever-changing sets of rules/norms, and roles. These complex systems dynamics are continuous, over the course of decades, years, and indeed, day-to-day. Complexity confounds the traditional analyst's bias toward categorization, standardization, grouping and neat linear thinking. Engaging myriad social systems with dynamic roles, norms and behaviors, the international development program designer and manager is constantly challenged by complexity.

2.1 Definition

Definitions of complex systems abound. In the USAID context, complexity is defined as "where cause and effect relationships are poorly understood, ...where expected results may require refinement and revision as strategies and projects unfold. [This includes] projects (or parts of projects) that rely heavily on adaptive management to steer effectively in dynamic contexts, and projects that seek to influence social change or innovate to discover solutions." Systems are defined as "those interconnected sets of actors—governments, civil society the private sector, universities, individual citizens and others—that jointly produce a particular development outcome."

In our research we have encountered multiple conceptual paradigms to refine our understanding of complex systems, with the following systems features being most useful for the purposes of SPACES MERL:

- *Elements*– These are actors within a system. They can be both formal and/or informal, and are often referred to as "stakeholders" in the international development context.
- *Interrelationships*– Interrelationships refer to the ways elements of a system are connected, and the resulting consequences of the nature of the relationship. This includes: dynamic aspects, such as the way interrelationships affect behavior of a situation over time; nonlinear aspects, oftentimes known as "feedback"; sensitivity, where the same intervention in different areas has varying effects; and finally, entanglement of relationships, distinguishing between simple, complicated and complex ones.[1]
- *Perspectives* – Perspectives incorporate *how* ones look at the picture, as people will see the same interrelationships in different ways. This includes investigation of: the different ways a situation can be understood, the ways different understandings affect how people judge success of an activity, and the ways that people's different understandings affect their behavior.[2] This allows for systemic inquiry on interconnections.
- *Boundaries* – Boundaries provide parameters and limits on the system. They help determine what is "in" and what is "out". Issues of power may arise when boundaries are set and it is important to understand: how the situation is being frame, who is drawing the boundary and what are the practical and ethical consequences of this framing and what do the consequences imply for action.[3]
- *Function or purpose*– The function or purpose is the intended result. Since a system is more than the sum of its parts it is necessary to understand: how the functions of the elements within the system differ from/add- up to the system's function, how the system differs from its initial appearance, what we think it is or what it should be. Function is often the most crucial determinant of the system's behavior.[4]

USAID uses a results-oriented lens, defining a "local system" (where local refers to actors in a partner country) as "those interconnected sets of actors -- governments, civil society, the private sector, universities, individual citizens and others -- that jointly produce a particular development outcome."[5]

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1 Williams, B. and Hummelbrunner, R. (2011). Systems Concepts in Action: a Practitioner's Toolkit. Stanford: Stanford University Press.

2 Williams, B. and Hummelbrunner, R. (2011).

3 Williams, B. and Hummelbrunner, R. (2011).

4 Meadows, D. H. (2008).

5 Fowler, B. & Dunn, E. (2014). "Evaluating Systems and Systemic Change for Inclusive Market Development

USAID highlights the “Five Rs” of local systems: Resources, Roles, Relationships, Rules, and Results. The use of “Resources” and the ensuing “Results” can be seen as the purpose of a system; “Roles” describe the functions of individual actors; and “Relationships” are types of interconnections and “Rules” govern the interconnections.

3. FRAMEWORK OF SYSTEMS APPROACHES TO DESIGN, MONITORING AND EVALUATION

Results-based management approaches predominate the international development landscape, characterized by familiar logical frameworks, performance management plans, and clearly defined indicators. What do all of these things have in common? They provide the program designer / implementer with a means of bounding their activities to dynamics within a system that they can control. Most of these familiar project design and performance monitoring tools acknowledge the complexity of the systems within which they operate, typically in the form of an “Assumptions” or “Risks” column, box or narrative. However, they neither attempt nor succeed in capturing and adapting to them.

For the international development practitioner, the problem is further compounded by the very nature of international development assistance. International development programs typically operate in highly fragile and disaster-prone environments, oftentimes lacking predictable governance frameworks and norms. Sources of human capital and funding are external, oftentimes not allocated through traditional means, meaning tremendous potential for systems catharsis, or conversely, disruption. Further, programming tends to be designed, monitored and adapted by relative outsiders, in many cases being expatriates unfamiliar and external to the system they are engaged with. This in itself provides strong justification for the imperative of utilizing systems analysis in international development context, and grounds the linkage between systems-based and locally-led approaches.

3.1 Utility for Design, Monitoring and Evaluation

SPACES MERL takes systems approaches as not only helpful for program design, but instrumental for dynamic monitoring, evaluation and learning. In this regard, employment of systems tools is central to good adaptive management practice, and should be accompanied by project / activity-level flexibility and means of adaptation.

USAID and implementing partner landscape are experiencing a shift toward systems approaches to design, monitoring and evaluation, including a first-time acknowledgement in the revised ADS and multiple instances of piloting and testing across missions. So, what then is the utility of complex systems approaches to program design and adaptive management?

Informing design: Familiar approaches to program design include qualitative pre-project needs assessment, typically shortlisting a group of stakeholders for consultations on constraints and opportunities. Done systematically, this can be an effective strategy. However, such assessments most often miss the larger system, artificially bounding their focus (and by extension, “the system”) to particular actors and behaviors of interest. All too often, the larger system is only accounted for in a set of risks and assumptions, for which the subsequent program design makes no attempt to control or adapt to.

Literature Review and Synthesis.” LEO Report No. #3. June. http://pdf.usaid.gov/pdf_docs/PBAAC412.pdf

A good design-level systems approach starts by mapping the broader system, including as many actors and dynamics that may impact on a program's area of interest as possible. Multiple analytical tools may then be used to establish boundaries of the system, identify stakeholders, opportunities and constraints, anticipate behaviors, prioritize interventions, establish a flexible management plan, and design-in strategies to track dynamic systems change and adapt programming accordingly. There are numerous such tools at the disposal of the systems designer.

Guiding adaptation: While good systems-based program design may be *a priori* to good programming, we are still only part way there. A fundamental tenant of complex adaptive systems is that systems are ever-changing and consist of multiple levels. While our systems-level program design challenges us to anticipate emergence as a result of our programming, dynamic systems change requires tracking once programs are underway. Systems tools that are appropriately selected, and reinforced by a management plan and orientation that accommodates adaptive management, are a powerful means of guiding adaptation as we go.

3.2. Categorizing Systems Tools and Approaches

Categorizing systems tools and approaches is a significant challenge, and the subject of much debate among academics and practitioners.

3.3 SPACES MERL Taxonomy of Systems Tools

Recognizing that systems tools present categorization challenges, have tremendous overlap and reinforcing qualities, SPACES MERL suggests a taxonomy roughly aligned with USAID's own, but including some key modifications:

Category	Visualization methods (Mapping)	Visualization methods (Modeling)	Narrative-based approaches	Indicator-based approaches
Examples of Tools and Approaches	• **Social Network Analysis** • **Systemigram** • Participatory Systemic Inquiry	• International Futures • Causal Loop Diagrams • **HERMES** • **RHEA** • **JANUS** • TreeAge	• Most Significant Change • Outcome Harvesting • Scenario Planning • **Innovation System Analysis** • **Innovation System Enablers and Barriers**	• **The Dynamic Project Trajectory Tracking Toolkit** • Process Monitoring of Impacts • Sentinel Indicators • Outcome Mapping Approaches

**Tools / approaches represented by the SPACES MERL team are in bold above*

While not all tools fit exclusively in one category, it is useful to provide a framework to facilitate understanding of the unique utility of each category and tool. Each complex system tool or approach has its strengths and weaknesses, so it is necessary to emphasize that people use the tool or approach that is relevant to the issue of interest. The following sections provide in-depth descriptions of the taxonomy laid out above, as well as profiles of complex systems tools within each category.

4. VISUALIZATION METHODS (MAPPING)

4.1 Definition

A systems map is a tool that can be used for thinking and communication, typically formed of shapes and words, illustrating a system of interest and employing a hierarchy of groupings. Systems mapping and visualization methods are one of the most effective and compelling means of enabling program designers, managers, evaluators and local stakeholders themselves to understand a system and their place within it. Systems mapping serves as a powerful approach for engaging diverse stakeholders, infusing greater understanding of the role that they have to play, and infusing ownership among them for development interventions and policy change.

Systems mapping techniques are diverse and varied, all attempting to gain a more holistic understanding of the system, and in many cases, track emergence within it. Some popular visual systems mapping techniques include community mapping, social and transactional network analysis, Systemigrams, Causal Loop Diagrams, and Participatory Systems Inquiry, many of which are addressed specifically in this section.

When used for planning, this approach involves first visually mapping the system of interest and then identifying which parts and relationships are expected to change, and how. This process can occur in various ways. For example, it may involve key informant interviews or other forms of data collection to capture what the system looks like and how it is functioning. Alternatively, it may be co-constructed using a facilitated group process. Systems maps may focus on and capture a number of systems features, which can sometimes be difficult to disentangle and require coding on a single map. Such features may include systems actors, relationships, perspectives, commercial transactions, resources, locations, among others.

When utilized to track emergence, systems mapping is often repeated at multiple intervals. These intervals are most often associated with a project or activity, ideally one which incorporates adaptive management practices to infuse learning associated with changes in the map, feed the learning back into project management processes, adapt and report back. More sophisticated mapping applications may employ a means of assessing causality of systems change, and attribute such causality to impact measurement activities.

4.2 Subcategorization of Mapping Methods[6]

Within a system are stakeholders that can include individuals, organizations, networks of organizations, the range of their actions, their ways of thinking about the issue, and the natural and human-created environmental factors that influence the system. Stakeholders may or may not identify themselves as participants in the system. One of the challenges of developing an issue system is to build participants' identity with it; this is critical to creating effective action to realize opportunities, address needs and respond to challenges.

A core concept in systems mapping is "purpose". Generally, there are three types of purposes for mapping activities undertaken in the international development sector, including analysis of production systems, issue systems and mental models.

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[6] This section excerpted from: http://beth.typepad.com/beths_blog/2009/10/guest-post-by-steve-waddell-systems-mapping-for-nonprofits-part-1.html

Production System: The purpose here is the actor itself, and the maps describe relationships and roles in realizing their purpose; this commonly models how organizations and individuals do their work. The production system maps aid an organization to understand how work actually gets done, in comparison to formal org charts. This analysis can assist in bringing greater alignment between the two, which in turn reduces conflict and enhances productivity.

Issue System: This system is where actors are one of many entities that are working to address an issue such as health care, maize production, deforestation, peace, and community development. Issue mapping allows actors to understand key leverage points in the bigger system it is trying to influence. These are points that, when focused upon, have a large ratio of amount-of-effort to desired-change. The focus can involve application of resources, or actually reducing resources.

Mental Models: These visuals describe how people (individuals, groups) think the world works, such as theories of change, power structures, and cause-effect models in general. Mental model mapping can uncover conflict, make it discussable, and enhance effectiveness. People can understand why someone else is doing what they are doing. Often this helps people understand that their mental model may be important, but incomplete in relation to the change goal – and therefore help people's respective efforts connect much more effectively.

4.3 Uses and Types of Questions that Can Be Addressed

Systems mapping activities are most typically undertaken by development practitioners in the early stages of engaging with a system. In this regard, systems mapping techniques can be understood to be an effective first-step, enabling stakeholders to gain a better understanding of the system and their place within it. Nonetheless, the technique can also be utilized to understand emergence and dynamic systems change over time. In these cases, the method is most frequently applied in multiple iterations. Systems-based development programming will oftentimes hard-wire in adaptive management practices in order to quickly respond to shifts within the system as they are detected. Some of the most frequent uses of systems mapping are outlined below.

Stakeholder mapping (design stage application): Stakeholder maps focus on actors and their place within an issue system or environment. They are often devised to gain a preliminary understanding of the most effective means of engagement within them. Techniques can range from basic "community mapping" processes conducted with a group of stakeholders assembled together in a room for just a few hours, to highly sophisticated quantitative network analysis employing enumerators, analysts and taking place over the course of several months. Stakeholder mapping does well to highlight key actors, enables the mapper to identify prominent features, potential resources, and bottlenecks within the system. It, however, requires a high degree of contextual knowledge of the system, is subject to the biases of those participating / leading, and success rates will often depend upon levels of participation.

Program and policy design (design stage application): Systems maps can be an effective tool for program design, another popular utilization of them. While stakeholder mapping data oftentimes contributes to this, program design applications will frequently push into a greater level of depth, identifying specific opportunities and constraints within "first-cut" systems maps, and drilling down to increasing levels of detail. This assists program and policy designers to identify key leverage points within the mapped system, assess systems change that may result from a specific policy or intervention, and subsequently take action through program or policy initiatives.

Project monitoring (longitudinal application): Mapping techniques that capture systems change over time can be powerful tools when linked to adaptive project implementation modalities. In this case, maps will be generated prior to the outset of a project, policy change, or intervention, constituting a static baseline. As interventions get underway, mapping processes can be repeated (oftentimes with the same participants), and changes in the system highlighted. At this stage, causality is assessed to the extent possible, oftentimes linking any observed changes in the system to interventions undertaken by a project. Interventions may in-turn calibrate activities to achieve desired results, provided that the systems mapper has a reasonably confident understanding of cause and effect relationships within the system being analyzed.

Program impact assessment (longitudinal application): A higher level function absent in most systems mapping tools, impact measurement requires an experimental method. One mapping tool that demonstrates strong potential for experimental application is social network analysis. SNA does this by applying the analysis with the same populations in multiple iterations before and after specific program interventions, examining differences in specific metrics between actors targeted by the intervention (treatment) and control groups. This approach generally requires an understanding of which stakeholders will and will not be engaged by the project prior to its initiation, and careful selection of indicators and attributes at the research design stage.

4.4 Overall Strengths

Visual format: While systems maps can be complicated, they provide a compelling medium to convey understanding of complex systems. Such visual representations can break down barriers between systems experts and laypersons, overcome linguistic and literacy constraints, and greatly increase the accessibility of systems approaches as a whole. This creates a greater ease of understanding and addresses a key constraint of systems approaches more generally: their levels of complexity.

Participation: Visual mapping approaches extensively utilize participatory approaches to data collection, visualization of the maps themselves, and assignment of meaning / analysis. This approach is capable of bringing diverse actor groups together to understand a particular system and, jointly or separately, develop solutions. This can be a key to the success or failure of subsequent development interventions, particularly in the international development context where programs are oftentimes designed by relative outsiders.

Excellent first-step: A multitude of systems tools and approaches have mapping hard-wired into their preliminary attempts to understand the system. Virtually all systems mapping techniques do well to facilitate understanding of the most prominent or influential features of a system. While greater detail and rigorous analysis is often required following these first steps, systems mapping is a highly effective “ground-zero” tool to begin understanding the system.

Diversity of approaches: Systems mapping approaches are myriad, and are flexible enough to be employed rapidly or in great depth. Systems mapping techniques can visualize a host of systems features, including actors, roles, relationships, perspectives, experiences, transactions, human and capital resources, among others. The trick oftentimes comes in selecting the most appropriate systems mapping approach for a given situation.

SNA has quantitative capabilities: Social Network Analysis is a particularly promising visual systems mapping approach, combining the visual appeal of systems mapping tools overall with a high degree of analytical rigor that can be applied at multiple stages of the program cycle.

4.5 Overall Weaknesses

Vulnerable to haphazard application: While the wide diversity and variance among systems mapping approaches can create an appealing menu for program designers, managers and evaluators, systems mapping tools are frequently applied in a way that is not fit-for-purpose. As discussed elsewhere in this section, only a limited number of systems mapping tools are capable of being applied for monitoring, impact evaluation and other purposes in a reliable way, and in many cases need to be augmented by a rigorous data collection and analytical process to ensure their validity. There are numerous hazards involved in representing incomplete application of systems mapping processes as a comprehensive systems approach, or sufficiently valid to make judgements on program design or success in application.

Oftentimes not data-driven: The specific systems mapping tools featured in the profiles in this text tend to be rigorous ones that are driven by meaningful data and quantifiable. This is not the case with many other systems mapping approaches, or ones that have been incorrectly applied. Examination should go into the extent to which reliable data is required and available to successfully apply a tool prior to embarking upon it.

Difficult to incorporate into results-based management approaches: Unlike indicator-based systems approaches, visual systems mapping tools can be difficult to incorporate into traditional results based project management approaches (e.g. logical frameworks, PMPs, workplans, etc.). Adaptive project management approaches are most conducive to accompany systems mapping tools.

Limited predictive value in free-standing application: Systems mapping tools generally rely on contextual knowledge, other data sources and stakeholder input to devise the most appropriate interventions and anticipate resultant actor behaviors and emergence within the system. In this regard, systems mapping approaches should always be scrutinized on their method of analysis prior to making important programming decisions. As well, experimental modelling techniques bear strong potential for application in concert with systems mapping. Important actors, entities, and influences identified via systems mapping can inform what needs to be represented in an experimental model. Similarly, mental model maps can be adapted into decision making models for experimentation.

Impact measurement: With the exception of SNA, we are not aware of visual systems mapping techniques that are capable of being applied utilizing experimental methods.

4.6 Profiles of Tools Currently Being Used by USAID

4.6.1 Social Network Analysis

A. **Summary**: Social Network Analysis (SNA) provides a structured, quantitative method for international development practitioners to better understand local systems in order to design, implement and measure results of their programs. Networks are comprised of three or more (typically many more) individuals or organizations (also known as “nodes”) that are each working toward a common goal or objective. Social Network Analysis (SNA) examines and compares the relationships between two actors (dyads), among groups of actors (clusters or cliques), and among all of the actors in the network. Attributes can be assigned to actors and to the relationships between them (also known as “edges”) to provide more depth to the analysis. SNA captures both the static (structural) and dynamic (changes over time) factors of complex local actor ecosystems, quantitatively measuring and tracking the ease with which information and resources flow within local systems.

B. **Tool Description**: SNA can be used as a stand-alone analysis for stakeholder mapping, partner identification, program design and evaluation. It can also complement other analyses such as household survey, Most Significant Change, and Organizational Capacity Assessment, providing unique insight into an organization's or cohort's context of work and the dynamics of the relationships they forge within it. The process includes three steps:

Network Parameter Definition

The SNA process begins with stakeholder consultations to define key network parameters. The parameters are then used to refine and contextualize the survey instrument and the data collection process – and are fundamental to ensuring that the network analysis will contribute to the learning agenda. Some key parameters to be established in this stage include:

Network Boundary: Which actors should be included in the network when collecting data? This typically includes clarification of a common goal of all actors, a geographic boundary, and potentially other characteristics dependent on the network.

Actor Attributes: What other actor characteristics are important to network analysis? Actor attributes allow us to segment data and analyze subgroups of network actors based on those characteristics. This typically includes type of organization or institution, technical area interests, and size or age of the organization.

Relationship Content: What types of relationships should be evaluated? Based on the learning objectives, types may include information sharing, resource sharing, collaboration, client-supplier, advice-seeking, or others. The quality of the relationships can also be evaluated by collecting data such as frequency of communication, level of the organization at which the relationship exists (e.g., executive, administrative, operational), utility, strength, or trust.

Target Respondents: Who should be interviewed / surveyed within each network actor? Even for organizational network analyses evaluating relationships among organizational or institutional actors, relationships are managed by individuals. The analysis is most accurate when the correct individuals (e.g., executive director, board members, program directors, operational managers) respond to the survey instrument.

Census / Data Collection

SNA utilizes questionnaire instruments to collect data on actors and their relationships. The questionnaires can be completed online using a computer or smart phone, or through phone or in-person interviews. While it may be preferable to be able to pre-identify all actors in the network prior to data collection, this is often not possible and important actors can be missed. In these cases, as known network actors are surveyed, additional network members are identified. Typically a snowball approach (network expands until all network actors are identified) or an ego-alter approach (network expands a set number of times) is applied. Depending on the parameters defined, network analysis can utilize secondary data from organizational or public records such as contracts and agreements, emails and other communications, or meeting attendance sheets. Additional secondary data helps contextualize the results of the analysis.

Analysis and Reporting

Once survey data collection is complete, LINC uses network analysis software customized to the international development context to examine the network as a whole (macro-level), and individual organizations (ego-level). It is typically most effective to first analyze the macro-level network for a few key metrics, which subsequently guides our analysis of individual organizations themselves. On this basis of this, results are analyzed and scores assigned to various indicators being tracked by a project or by network members themselves.

Several key variables are typically analyzed at the network level and for specific actors:

- *Density:* measures the number of ties between actors indicating the level of connectedness within the network
- *Centrality:* indicates which actors are most engaged and which are peripheral
- *Reciprocity:* measures the extent to which relationships reported by one actor are confirmed by the other actor
- *Distance:* calculates the average number of steps for any network actor to reach another actor
- *Clusters:* indicate the existence of sub-groups of actors that are completely interconnected (and often only loosely connected to the rest of the network, if at all)

Depending on the composition of the network and objectives of the researcher, actors will typically be sub-divided into groups to take advantage of the rich array of learning opportunities that the SNA affords. This enables our research to uncover findings related to specific types of social capital forged by networks and individual organizations, in addition to an array of standard network analysis metrics.

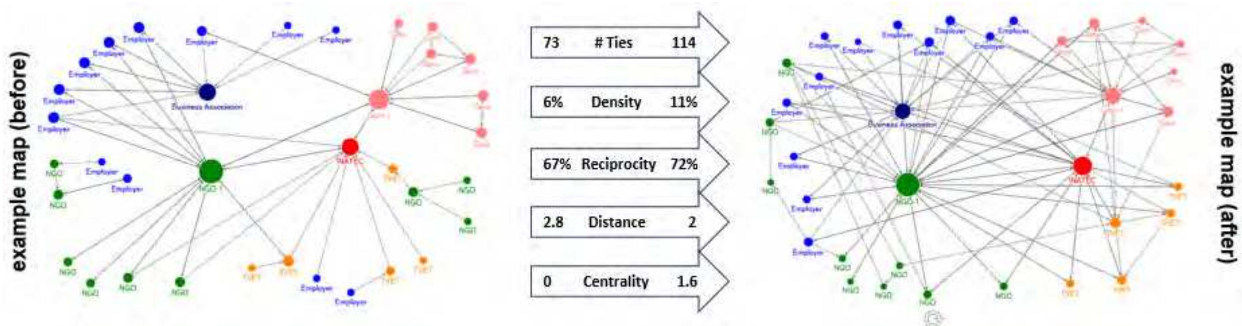
Longitudinal data can be used to analyze changes in the network over time. As a network evolves, the SNA is able to track impact on local systems against activities undertaken by projects. As a result, network analysis feedback loops enable program implementers to appropriately calibrate their interventions as they progress and learn from them.

C. **Tool Features**: SNA results have applications for both whole networks and individual actors, providing a powerful platform for decision-making on partnering strategy, program design, and evaluation of progress during or at the conclusion of program activity. This means that network actors, project designers and project implementers are able to customize and calibrate interventions build-upon strengths and target particular constraints within the overall network. Questions that SNA can help to answer include:

- Which actors are most central? Are they the most essential actors to address development goals? Which actors should a project or individual organization partner with?

- Which actors are most vital to network health, and therefore should be supported with capacity strengthening?
- Which actors could establish or strengthen critical relationships through incentives to collaborate or share information?
- Where within the system can we build resource hubs, including innovation, organizational, financial, informational or capacity-development resources?
- Does the structure / hierarchy of the system enable efficient sharing of information, resources and innovations?
- What are the power relationships within the network and how are decisions made?
- Which alternative pathways are available to address inequalities or power biases in the network?
- Which actors / relationships bridge geographies and/or technical areas?
- What is the level of trust / perceived equity among actors? Is it improving over time?
- Is the system growing over time? Is the system becoming more efficient over time?
- Is bonding, bridging and linking social capital increasing over time?

Figure: Illustrative pre- and post-intervention maps and metrics show network level change



D. Strengths:

Versatility: SNA is a versatile approach that serves program designers, managers and impact evaluators well to infuse rigorous systems analysis at multiple points in the program cycle. It has already demonstrated a high level of adaptability to varying international development contexts. This includes successful application in a range of sectors, and to a variety of populations with limited or no access to the internet. Further, SNA datasets can be utilized for a variety of other analyses, including experimental modelling and a range of systems mapping techniques.

Ease of Comprehension: Another key strength of SNA is its relative understandability to lay audiences and the availability of easily accessible network analysis software to generate basic metrics and powerful visualizations. There are a number of freeware network analysis platforms available, and data input is increasingly straightforward, minimally requiring a two-column Excel spreadsheet expressing one relationship per row.

Expedited Application in Connected Environments: SNA can be applied quickly and easily to networks that are well connected to the internet and all of the network members can be named in advance. In this case, it is a simple matter of setting up an online data collector that integrates with analysis software, exporting the data if necessary, and running the results.

Measures Social Capital: Assessment of social capital is a common aim of SNA, and it is one of the few systems tools that is able to capture these dynamics through a number of techniques. The most straight-forward approach that LINC uses to assess social capital specifically considers *bonding, bridging and linking* social capital through analysis of relations between *like* (homophilic) and *unlike* (heterophilic) groups. More sophisticated techniques involve survey of actors regarding aspirational relationships, or assigning proxies for social capital. The final and most comprehensive treatment takes the network data as a whole, applying established sociological paradigms combined with qualitative insights to interpret social capital network maps.

E. Weaknesses:

Analyzes Relationships, not Perspectives: SNA's primary shortcoming, and common point of confusion, is that the approach analyzes relationships, not perspectives of actors themselves. This means that the tool can generate rich information about the extent to which actors interact, the strength of that particular interaction, and the nature of it. It can also assign attributes to actors depending on the analyst's needs (e.g. formal vs. informal organization, male / female, etc.). However, the social network analyst will still be left to conjecture regarding the actors' perceptions of anything beyond the relationship itself. For this, other tools such as household surveys, ethnographic methods and narrative-based tools are typically drawn upon to infuse the SNA with richer interpretive capacities.

Census and Nomination Methods: While the basics of SNA are easy-to-understand and network analysis software is widely available, higher-level challenges emerge in rigorously applying the methodology and analyzing the results, especially in unconnected environments. The census methodology contrasts deeply with a survey-based one, especially in cases where all members of the network cannot be defined in advance of the research, require nominations. This means that nominees need to be vetted on an ongoing basis, and censused if they qualify for network membership. Some respondents can be difficult to track down, or refuse to participate in the study.

Analytical Complexity: Basic network metrics (e.g. density, reciprocity, closeness, centrality) are relatively easy to understand and analyze. Application of these metrics to social problems becomes increasingly complex, especially when advance metrics are included in the analysis (e.g. transitivity, cohesion, structural holes). This interpretation typically requires extensive experience and/or advanced sociological training. Ideally, the analyst should be highly familiar with the context of the network itself, or be augmented by local experts and other analytical resources (opinion polls, household surveys, etc.).

F. Examples of past use cases: LINC has applied Social Network Analysis with USAID funding to workforce development networks in Nicaragua. For the report, visit: http://linclocal.org/wp-content/uploads/Report_NicaraguaONA_LINC_FINAL.pdf. LINC is also applying a longitudinal SNA in three iterations (baseline, midterm, endline) to the DFID-funded IMAGINE project in Eastern DR Congo. This research assesses emergence in water governance networks over the course of the five-year program, from 2015 to 2019, helping guide program design, adaptation and impact measurement. For more information on this and other SNA resources, visit: http://linclocal.org/tools/network-analysis/.

Root Change has conducted Social Network Analysis to USAID programming in Nigeria. For more information on their work, visit: www.rootchange.org

G. **Resources required**: Resources required can range from just a few days of effort to several months or years. There are a number of variables impacting this, including:

- Network size
- Will the network analysis be conducted at one moment in time, or in several iterations over the life of a program?
- Can all of the network members be defined in advance of the research?
- Can all of the network members be reached virtually, using online instruments?
- In cases where network members are not connected to the internet, how advanced is the data collection system and personnel (including ability to handle nominations, vet potential network members, utilize tablets, and avoid naming redundancy)
- How narrowly is the network defined?
- How sophisticated will the analysis be?
- Extent to which theory of change is explicitly linked to the research.

Levels	**Pre-conditions/Goals**	**Time**	**Human Resources**
Easy	● All network members defined in advance and connected to internet ● Basic analysis ● Integrated data collection and analysis platform	1-3 weeks	1 designer/analyst/supervisor
Medium	● All network members defined in advance but not necessarily connected to the internet ● Basic-to-high level analysis ● 100-500 network members	1.5-3 months	1 designer/analyst, 1 supervisor, 3 enumerators
Difficult	● Some, but not all network members defined in advance ● Most respondents not connected to internet ● 100-500 network members ● High-level analysis5.7.	3-5 months	1 designer, 1 analyst, local experts, 3-7 enumerators

As a general rule of thumb, the "Difficult" category of network analysis conducted on a longitudinal basis will require overall resources similar to that of an impact evaluation. Time estimates given above start with research design and conclude with submission of SNA report.

H. **Tool Developer and Availability:** LINC offers an SNA tool that has been customized to the international development sector. For more information on this tool and related research reports, visit here: http://linclocal.org/tools/network-analysis/

Other SNA providers with products potentially conducive to application in the international development sector include:

- Kumu (www.kumu.io)
- Root Change (www.rootchange.org)

I. References:

Borgotti, S.P., Everett, M.G, Johnson, J.C (2013). *Analyzing Social Networks*. Sage Publications. London.

Burt, R.S. (2000). *The Network Structure of Social Capital.* Research in Organizational Behavior, Volume 22, p. 345-423.

Gesell, S.B., Barkin, S.L., Valente, T.W. (2013). *Social network diagnostics: a tool for monitoring group interventions*, Implementation Science, 8:116.

Taylor, M., Doerfel, M.L. (2004). *Another dimension to explicating relationships: measuring inter-organizational linkages*, Public Relations Review, 31, p. 121-129.

Williams, B., Hummelbrunner, R. (2009). *Systems Concepts in Action.* Stanford University Press. Stanford.

4.7 Profiles of Tools Not Currently Being Used by USAID

4.7.1 Systemigram

A. **Summary**: Systemigrams offer visual representations of the dynamics of a system and its context. Usually accompanied by a narrative, systemigrams are a type of "soft systems analysis," which seeks to explore complex situations through the perspective of those embedded in the system or those who are affected by the specific challenge.[7] Systemigrams allow the user to visualize a concept described in the narrative as a set of nodes and linkages, helping to clarify the root causes of complex challenges within the system. The resultant diagram provides insight into a system's architecture, its boundaries, phenomena or elements, actors, and critical relationships.

B. **Tool Description**: The term systemigram is derived from the phrase "systemic diagram."[8] Systemigrams are generally employed in the early stages of problem formulation, as stakeholders and analysts first conceptualize the system or problem under consideration.[9] The systemigram combines a collaborative process to create a narrative of the system and its dynamics with a 1-page diagram that models the narrative as a set of nodes and links. It is developed from the narrative text, which may be a compelling descriptive view of the system and its dynamics, or a strategic text written to analyze the behaviors of the system and directly used to produce the diagram.[10]

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[7] http://www.construction-innovation.info/images/pdfs/Research_library/ResearchLibraryA/Refereed_Conference_papers/Five_Case_Studies.pdf

[8] https://www.stevens.edu/sse/sites/default/files/Systemigram_Overview.pdf

[9] http://www.anser.org/docs/asyst-doc/Leveraging-Systemigrams-and-Their-Application-to-the-US-National-Security.pdf

[10] McDermott, T., Nadolski, M., Sheppard, L., "Use of Systemigrams to Identify Emergence in Complex Adaptive Systems", Georgia Tech Research Institute, 2015.

A formal use of the systemigram tool is guided by the following basic rules:

- The diagram fits on a single page.
- There is a beginning and an end; the main flow of the story is upper left to lower right.
- Entities are nodes, links, inputs, and outputs. Nodes are key concepts, phrases, or nouns representing entities or conditions.
- Links represent relationships and flow between nodes; they include verb phrases identifying transformation, belonging, and being. Links should not cross each other.
- Nodes may contain other nodes identifying other diagrams or groups.
- The layout of the diagram should be arranged to bring attention to the different levels of perspective in the system.
- Color can be used to highlight particular concepts and transformations.

C. **Tool Features**: As a conceptual modeling approach, systemigrams are used to convert prose to a visual representation for purposes of communication, storyboarding, and model understanding among stakeholders.[11] Major applications include systems-of-systems and networked systems, with potential uses being the representation of multi-level systems and enterprises.

D. **Strengths**: As a communication tool, the value of the systemigram process model is that it creates a shared system of values and perspective of the system from which constructive debate and analysis may take place. A systemigram that has been constructed and has become the subject of testing and evaluation, being reconstructed as a result of feedback, can be said to represent a shared view of understanding.[12]

The visual depiction of critical elements or phenomena in a system, depicted as connected nodes, and their relationship to one another, make it possible for users to easily understand how nodes are interconnected and influence each other. The visual depiction is also useful for analyzing commonalities and discords between the structures, processes, functions, and components of multiple systems. Users can gather valuable information, such as leverage points, to induce successes and prevent failures across a system.

E. **Weaknesses**: The developers of systemigram recommend using a storyboarding technique, such as a systemigram slide show, to engage the stakeholder audience in an iterative process of dialogue by walking through each of the strategy strands. As there may be various nodes and narrative streams that form part of the visualization, at first glance a systemigram may be difficult to interpret. By breaking up the systemigram in a step-by-step approach, the message of the systemigram can be conveyed, together with the message that the author(s) of the original narrative intended. [13]

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[11] Rouse, Dr. William B., Bodner, Dr. Douglas A., “Multi-Level Modeling of Complex Socio-Technical Systems, Phase 1”, Stevens Institute of Technology, 2013.

[12] Clegg, B.T. and J.T. Boardman. (1996). “Process Integration and Improvement Using Systemic Diagrams and a Human-Center Approach.” Concurrent Engineering: Research and Applications

[13] Blair, C., J. Boardman, B. Sauser. (2007). “Communicating Strategic Intent with Systemigrams: Addressing the Network-Enabled Challenge.”*Journal of Systems Engineering*. 10(4):309-322

Ideally, systemigrams are iterative and are strengthened over time through deliberation and feedback from stakeholders. However, this process can be time consuming and require skilled staff in the development and analysis of the visualizations and rewriting of the systems narratives.

F. **Examples of past use cases:** Systemigrams have been used by ANSER, a U.S.-based contractor, to compare responses to earthquakes and natural disasters as a method to improve response planning and establish practices to limit and mitigate disaster devastation. ANSER has also used systemigrams to analyze the U.S. National Security System as articulated by the U.S. National Security Strategy.[14]

G. **Resources Required**: The development and application of systemigrams can be a time intensive process, particularly if an iterative approach to gathering feedback and improving on the architecture and narrative elements of the systemigram is undertaken. Users must be trained on the proper rules and guidelines for the development of the narrative and the visualization, as well as facilitation approaches to gather stakeholder feedback. Use of available programs designed to create systemigram visualization would require additional costs.

Levels	**Pre-conditions/Goals**	**Time**	**Human Resources**
Medium	● 2 stakeholder workshops ● 3 weeks of data collection ● 3 weeks for analysis and systemigram generation	1-2 months	1-2 process facilitators for 6 weeks; large # of stakeholders to participate in workshops

H. **Tool Developer & Availability**: Blair, Boardman, and Sauser developed the systemigram approach as a way to transition between narrative and computational modeling. [15] There are examples of systemigrams and a tool called SystemiTool available on Blair, Boardman, and Sauser's website for download, requiring purchase of their book or an enterprise license. http://www.boardmansauser.com/thoughts/systemigrams.html

4.7.2 Participatory Systemic Inquiry (PSI)[16]

A. **Summary**: Participatory Systemic Inquiry, more specifically Systemic Issue mapping, enables the dynamics of complex systems to be seen. This in turn allows participants to identify leverage points within a system where action can be taken. Systems maps can be created from a variety of narrative-based data, including interviews, focus groups and life stories. Once these are collected, groups collectively analyze the stories and represent causalities and patterns on large maps,

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[14] http://www.anser.org/docs/asyst-doc/Leveraging-Systemigrams-and-Their-Application-to-the-US-National-Security.pdf

[15] Blair, C. D., Boardman, J. T., & Sauser, B. J. (2007). Communications Strategic Intent With Systemigrams: Application to the Network-Enabled Challenge. Systems Engineering , 10 (4), 309-322.

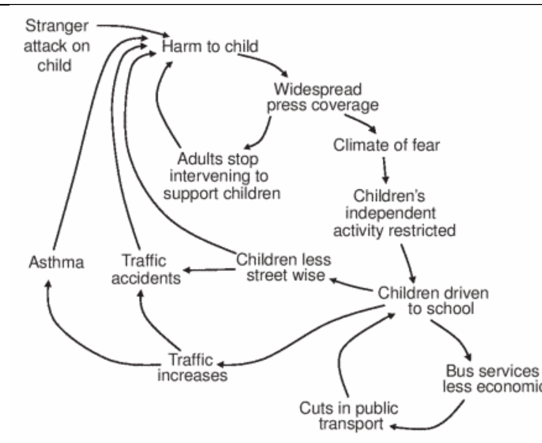
[16] Information presented below on PSI excerpted from: Worsley, Burns, *Navigating Complexity in International Development*, 2015.

enabling them to see the whole, and to see the relationships between the many factors depicted on the maps. The hallmark of PSI is its participatory nature, constructed upon narratives, making it highly flexible and engaging for stakeholders, but introducing questions on rigor and reliability.

B. **Tool Description**:
PSI is a foundational inquiry which is able to provide a comprehensive starting point (first cut) on the critical issues that need to be resolved and systems dynamics which underpin them, and which can lay down a baseline depiction of those interrelationships that can be interrogated and adapted over time. This can then feed directly into programs, into local action, or into an organized Systemic Action Research (SAR) process.

The PSI inquiry process explores the interrelation of factors across a social system through a process of systemic mapping. First-cut systemic issue and relationship maps are generated (usually large and messy), gradually leading to more distilled system dynamic maps. Although not the focus of this paper, an alternative approach is story-based, leading to the identification of systemic patterns through a collective analysis of change in individual lives. What is common to both of these processes is that they are rooted in the experiences of the people that will be the central beneficiaries of the inquiry (and any outcomes generated from it) and that the analysis is done by them and their peers. There is of course some overlap as mapping based approaches may often draw on life stories (as well as the many other data sources) and narrative-based approaches create implicit, if not drawn, systems maps.


Early-stage “messy map”



Later-stage distilled map

Maps excerpted from Burns, D., Worsley, S. (2015) *Navigating Complexity in International Development: Facilitating Sustainable Change at Scale*. Practical Action Publishing, Rugby.

C. **Tool Features**: PSI’s primary utility is in its ability to incorporate multiple perspectives into a program design or baseline generation process. The system that everyone sees is different; the connections they see are different; the vision they have of different parts of the system is different; their interpretation of what is important is different. To understand how a social system works, it’s important to see it from multiple perspectives and to juxtapose them in order to discern what people see in common and what they see differently. These differences can be debated in real time ‘over the maps’. Maps can be compared and patterns identified.

However, it is very easy to create groups of ‘people like us’ when engaging in participatory efforts. This has to be intentionally countered for an effective PSI process. This means explicit incorporation of the following narratives:

- Dominant narratives – reinforce the existing balance of power which shape and maintain local social norms;
- Alternative narratives – counter-narratives that emerge from different locations within a system. These narratives are often, but not always conflictual;
- Hidden narratives – those that are not immediately visible. They are important because they can provide insight into way of unlocking change within a system dynamic that isn’t always obvious.

The data collection process itself may involve many different methods. These can include:

- Transect walks, observations and explanation, photographs;
- Participatory number / statistic generation
- Connected real-time conversations
- Peer research processes
- Dialogic / group based spaces
- Visual / creative processes

As well, traditional methods of inquiry can also be useful, including secondary research, interviews, surveys and network analysis. The key thing to be clear about is that it is not the data which makes the process participatory, but rather, the question of who it is analyzed by and how. In this regard, data sources and methods will likely vary significantly from one situation to another.

Irrespective of the data collection method and sources utilized, it is critical in PSI to ensure that there is some process of collective analysis from people across the system. It is not enough to collect data from people in different parts of the system, but they should be significantly engaged in analysis and assignment of meaning. Collective scrutiny can happen in many different ways. For example, an inquiry team of community participants might analyze the data together or, when stories have been mapped, community representatives might be asked to engage in the refinement and analysis of that map.

D. **Strengths**: PSI’s chief strength lies in its method of capturing diverse stakeholder narratives, engaging stakeholders themselves in assignment of meaning to these narratives, collectively identifying solutions, and projecting all this visually in the form of a map. In this regard, the tool has tremendous utility in shaping programs and interventions that are locally-led, especially in contexts where there are high degrees of consensus and a will for collective action. Constituents themselves can participate in and guide the process, rather than external analysts. This generally results in higher degrees of local ownership over development solutions.

PSI is an excellent means of bringing multiple stakeholders together to better understand issues within the system, or a development problem, and iteratively develop solutions. This can represent an important first-step in systems analysis, greatly informing program or policy level design solutions.

E. **Weaknesses:** As with many other participatory processes, PSI depends heavily upon who is engaged and the influence they exert over the process. This requires savvy facilitation, a convener that is respected by diverse parties and steeped in local knowledge. There is typically a high degree of subjectivity built into this, making it difficult to ascertain in which cases the results of a PSI process are indeed representative of the system as a whole, or biased toward one particular narrative.

PSI data sources and collection methods are varied, participants may change from one iteration to another, and analytical processes are subjective. This means that the tool would be difficult to employ for any sort of quantitative analysis or assessment of causality with statistical validity.

F. **Examples of past use cases**: We are aware of two detailed case studies of applications of mapping-based PSI, both of which are written-up in a 2015 Practical Action publication entitled, "Navigating Complexity in International Development: Facilitating Sustainable Change at Scale" and referenced below. These two projects are:

- Lake Victoria Water and Sanitation Program (LVWATSAN), funded by UN Habitat in Tanzania, Uganda and Kenya.
- Ghana Community Radio Climate Change project, self-led initiative.

G. **Resources required**:

Pre-conditions/Goals	Time	Human Resources
● Define issues related to the system, generate "messy maps" and gradually distill them down, and conduct participatory analysis. • Generally participatory workshops should be conducted both before and after the data collection • Dependent on nature of data collection	2 weeks to several months	Expert guidance, large number of stakeholders to participate in workshops

H. **Tool Developer and Availability**: Participatory Systemic Inquiry is a relatively new method, basic information of which can be found online. We are not aware of any organizations with proprietary ownership of the tool. We recommend consulting the references indicated below, which are some of the few available at present.

I. **References**:

Burns, D., Worsley, S. (2015) *Navigating Complexity in International Development: Facilitating Sustainable Change at Scale*. Practical Action Publishing, Rugby.

Burns, D. "Assessing Impact in Dynamic and Complex Environments: Systemic Action Research and Participatory Systems Inquiry". Center for Development Impact Practice Paper. (Issue 8, September 2014)

4.8 Identified Gaps

Systems mapping visualization methods produce an output that many, if not all, development practitioners are highly familiar with. This tends to create a basic level of familiarity with the method within USAID and elsewhere. Nonetheless, the systems mapping tools presented in this section are unique, specifically in that they employ systematic methods to collect information / data and interpret it effectively. This is most often not the case with other more familiar systems mapping methods such as community mapping, for example.

Gap 1: Given that the systems mapping methods presented here within appear highly familiar to most development practitioners, they are, in turn, highly prone to haphazard implementation. This is particularly the case with the Systemigram and PSI tools, both of which offer high degrees of flexibility in determination of the data that they actually collect and analyze. While not all systems mapping methods need to be conducted systematically, it is not uncommon for such haphazard applications to be dubbed a "systems approach" when they have in fact not been implemented as such.

Gap 2: Overall, we have found very few examples of application of *systems-based* mapping and visualization, at least for the tools that we analyzed in-depth (SNA, Systemigram, PSI), within the USAID community. The predominant modality for assessing and understanding systems at the design stage within USAID appears to be qualitative assessment and stakeholder mapping.

Gap 3: Efforts are required to bring system mapping applications in-line with a largely results-based management orientation of USAID's program cycle. As highlighted earlier, systems mapping methods do not easily align themselves with traditional means of project measurement and reporting. Nonetheless, their applicability to design and initial steps related to understanding the system are highly evident. SNA data, for example, can be incorporated into project reporting metrics and associated with interventions. Examples from practice, however, are rare.

Gap 4: Investment in undertaking systems-based mapping and visualization methods is significant, requiring inputs and significant time from multiple actors throughout the system.

Gap 5: SNA enjoys a very well-defined data collection and analysis process. Data collection itself is a census, data is crunched in network analysis software, and meaning is assigned through interpretation of that data (most effectively in concert with other informational sources / tools). SNA methods articulated to date do not mandate any particular methods for participation and engagement of constituents. The process can, nonetheless, be highly participatory and engaging when conducted in partnership with local institutions, engaging stakeholders on research design, collection and analysis.

Gap 6: Within USAID and elsewhere, SNA is most typically associated with analysis of formal pre-defined networks (e.g. Twitter, formal associations, etc.). However, the method enjoys much wider applicability. Depending upon how the network is defined (at minimum, a common goal), members of the network generally do not even think of themselves as part of a network. There is a challenge move forward in building understanding of the wider applicability of this tool to informal community members, sector-based collaborations and otherwise.

4.9 Recommendations

Recommendations related to systems mapping visualization methods directly relate to the above-cited gaps and weaknesses of tools, identifying opportunities for development and mainstreaming of these methods within USAID and the larger development landscape. Recommendations include the following:

Recommendation 1: We see an opportunity to better integrate and define SNA's rigorous data collection and analytical methods with PSI's highly participatory process and customize it to the international development context. This addresses shortcomings in both of the tools at present, and the SNA method itself is conducive to such integration. This might include in-depth stakeholder workshops incorporating diverse participants and perspectives into research design and questionnaire development, participatory implementation of census activities, and joint interpretation of results / analysis.

Recommendation 2: Systems mapping visualization methods are most easily understood and applied at early design stages of programs and activities. There are nonetheless a number of applications for such tools for project monitoring and evaluation, as highlighted above. While systems mapping applications may find their easiest entry point at project design, we suggest advocacy around their application for full project cycle implementation. SPACES MERL pilot opportunities that carry through the project cycle might be prioritized in this regard.

Recommendation 3: Awareness building within USAID of systems mapping tools and concrete examples of their application should be prioritized. This includes learning from other donors such as DFID that may have more history and experience in applying such methods.

Recommendation 4: Investment in making systems mapping visualization methods less time and resource consuming should be explored, particularly in regards to addressing the concerns of many mission-based staff and implementers that such activities are too time and resource intensive to justify their investment. This may however require compromises in the rigor of applying such tools.

5. VISUALIZATION METHODS (MODELING)

5.1 Definition

While Systems Mapping techniques establishes the players and their interconnections, mathematical and computational modeling techniques fills in all of the other relationships, processes, actions, and other factors that comprise the system. Modeling can incorporate dynamics to the system, allowing users to see how the current system may evolve and how changes to the system may affect it over time. There are many ways to approach modeling from simple *Mathematical Modeling* to more complex *Simulation Modeling*. *Mathematical modeling* establishes a set of mathematical equations that represent the system. *Simulation Modeling* creates a prototype of a physical system that mimics the system's real behavior. *Computational modeling* refers to techniques which formulate a model digitally and uses a computer to determine the outcomes of a model. An important distinction is that a model is not a replica. A replica is an exact copy of something. By contrast, a model is a simplification of the actual system, representing the elements, factors, relationships, and processes of the system that are relevant to the questions, decisions, and actions of interest to the user.

Models can be *Deterministic* or *Stochastic*. *Deterministic* models have outcomes that are fully determined by the initial conditions and inputs. Many *Mathematical Models* are *Deterministic* and given the same inputs and parameters, the outcomes are identical. *Stochastic* models have outcomes that are subject to some inherent randomness and given the same set of initial conditions and inputs, the model may produce different results. *Stochastic* models are required to be run as ensembles so that proper statistical sampling can be done to produce meaningful outcomes. *Simulation Models* of populations are generally *Stochastic* as there is a great deal of randomness in the system.

Models can help better understand a system and also serve as "virtual laboratory" to test various changes in the system, replacing the costly process of trial and error in improving systems performance. The obvious benefit of modeling is the ability to model scenarios and outcomes from the current and changed system, but there is a myriad of other benefits. Building a model gives one a better understanding of the system for it involves mapping important components and relationships in the system. Models are also a place to tie all of the system's disparate data sources together in one place and can guide data collection by elucidating data gaps and the relative importance of different data elements. Finally, models provide a very effective means of communicating the complexities of real-world systems and can be used as evidence-based advocacy for improvements.

Building a model consists of the following steps:

- Map the system: Determine the components of the system and their connections/relationships. This is the step where techniques such as *Mapping* described in Section 4 Above can be very useful.
- Develop equations or algorithms to represent the relationships, processes, and actions in the system.
- Populate with data: Assign parameters in the model based on literature values or data collection.
- Calibration: Tune unknown parameters of the model to match known data.
- Verification: Ensure that the model is producing expected results based on its formulation.
- Validation: Analyze whether model outcomes match known data that was not already used to parameterize and calibrate the model.
- Modeling experiments: Change parameters or inputs to explore how changing the model results in different outcomes.
- Sensitivity analyses: Systematically change one or multiple parameter(s) or input(s) in the model to determine trends in model outcomes.

It is important to note that these steps are not done in isolation, but are a part of a larger iterative process. Once a model is completed and experimentation is completed, the knowledge about the system evolves and that knowledge can be fed back into mapping the system and improving the model.

5.2 Subcategorization of Modeling Methods

Modeling methods can fall into the following categories. These categories are not completely distinct but can be used as a guide to organize models.

<u>Decision analytic models</u> – Decision analytic models focus on an individual's decision or actions. Decision analytic models systematically map out all of the relevant factors or influences involved in a decision. These influences include external pressures, internal beliefs and values, and environmental constraints. The model also identifies all possible outcomes of the decision situation. This type of model elucidates the salient factors involved in the decision.

<u>Markov models</u> – Markov models are useful when an individual faces the same possible decisions or actions again and again over time. They represent an individual's progression through different conditions and events. Markov models can also include interdependencies between different progression paths.

<u>Compartment and Systems Dynamics Models</u> **–** Compartment and system dynamics models divide all the parts of a system into what would be analogous to rooms in a house and then represent how components like people would flow like a mass or liquid through the different rooms. Relationships between the rooms or compartments dictate how people move between rooms. Compartment models demonstrate how impacts to one compartment can cause unforeseen consequences in other compartments. Users can view

population trends over time and observe compartment size breakpoints

Network models – Network models define in greater detail the connections between different players (e.g., people or organizations) in the system and how the players influence each other. In this manner, network models tend to account more for the heterogeneity of players in a system.

Agent-based models - Agent-based models, sometimes called Individual-based models, give individual players autonomous decision making ability and complex adaptive behavior (the ability to learn over time). Computational entities known as "agents" are given individual state and decision making abilities that allows them to interact based on their individual situation and rules. The agents can interact with each other and the environment. Once the rules for how agents interact are determined, the system is simulated by allowing these rules to dictate the evolution of the system over time, and therefore the outcomes of an agent-based model are "emerged" from the sum of all of its parts. Agents can also evolve their own state over time based on their experiences throughout a simulation. For example, agent-based models are widely used to represent populations, where each individual person is represented by an agent.

5.3 Uses and Types of Questions that Can Be Addressed

The results of computational models help researchers determine factors and relationships and forecast future scenarios in response to changing conditions in a particular system. Models can also aid in the design and development of relevant policies and interventions. Relatedly, models can assess the potential impacts of policies and interventions, including their potential secondary and tertiary effects and unintended consequences. Additionally, models can guide and prioritize data collection by identifying gaps and demonstrating the effects of having better information.

Models can address the following types of questions:

- What is the likely impact of introducing new technology on a system?
    - Example: New products, storage and monitoring
- What happens when you change the characteristics of products, agents and other technologies?
    - Example: Packaging size, agent preferences
- What happens when you alter the configuration and operations of a system?
    - Example: Impact of new policy for schools, impact of increasing vaccine coverage
- What are the effects of differing conditions or circumstances on a system?
    - Example: Inclement weather, delays in implementation
- What is the most cost-effective investment or allocation of resources?
    - Example: most cost effective technology to increase food supply
- How can you optimize product delivery?
    - Example: minimize cost, maximize demand satisfaction

Computational Simulation models are applicable at all stages of the program cycle:

- Country and Development Cooperation
    - Can identify strengths and vulnerabilities of system
- Project Design and Implementation
    - Test different options
- Monitoring
    - Simulate the impact of different measures
- Evaluation
    - Project to various outcomes

- Learning and Adapting
    - Test how system may change over time and conditions

5.4 Overall Strengths

Modeling is a bridge to translation. Modeling can and does occur at different time points along the research path from idea inception to policy or intervention implementation. It can help plan retrospective and prospective studies. It can extrapolate results from one circumstance to another and can extend information from one place to answer questions in certain locations when data comes from another source. Additionally, modeling can save time and effort normally associated with trial and error.

Below are strengths of modeling tools matched to the USAID program cycle.

- Country and Development Cooperation
    - **Help decision-makers map out the components and relationships in complex real-world systems.** Real-world systems are complex, with many interrelated and interacting components that can be difficult or impossible for a person to fully understand or comprehend in their head. Modeling can be used to represent these components and their relationships systematically, with each relationship mapped out. Just by creating a model, one can gain a greater understanding of the system, in a way that is not possible otherwise.
- Project Design and Implementation
    - Project Design
    - **Help decision-makers determine which relationships and factors are most important.** Models allow one to explore the most important factors effecting a system. With a complex system, it is difficult to tease out what factors truly effect the state of the system and which are less important. Many try to perform data driven statistical correlation analysis, which can be useful, but cannot guaranteed to produce the truly important aspects of a complex system. Also, it is very difficult to see the synergy between multiple factors simultaneously and a model allows users to perform one-way, two-way, three-way, etc. sensitivity to change any component of the system in a systematic manner, giving the model the ability to not only determine the importance of individual relationships, but combinations as well.
    - Implementation
    - **Give decision-makers a "virtual laboratory" to test improvements to the system instead of the costly process of trial and error.** Models can serve a "virtual laboratories" which allow users to assess the current state of a system, change aspects of the system, and explore external stimuli. In the real-world system, if one wants to test an intervention that may change a system, costly and time consuming pilot studies are done. A model can be used prior to, or in conjunction with implementation to explore a myriad of possibilities, helping to narrow down which interventions may have the most impact.
- Monitoring
    - **Help decision-makers see non-intuitive or unintended consequences of changes to the system.** With a dynamic model, especially mechanistic models, outcomes from the complex systems become emergent (i.e. they are not predetermined, but instead a

consequence of the rules and inputs of the model). This will allow for the possibility of seeing unintended consequences of the interactions between various aspects of the system (e.g. increasing availability of healthy food at a location but getting the timing of such availability wrong may not improve the population health). Such effects are very difficult to see through data-centric analysis or static modeling techniques. Users can model interventions that are in the process of implementation to understand the future impact of the intervention to better understand how the rest of the project will unfold which provides unique insight and allows users to adjust accordingly.

- Evaluation
    - **Help decision-makers understand how a system and the resulting outcomes and impact change over time.** Real-world systems are dynamic, with all of the components interacting throughout time. A dynamic simulation model can show how these relationships truly evolve temporally. Dynamic simulation models are able to represent the interactions in a system that will not necessarily be the same given the conditions changing in complex ways over time.
- Learning and Adapting
    - **Help guide costly data collection efforts by targeting data that is going to have the most impact.** Collection of data can be a difficult and costly process, and performing sensitivity analysis with a model can be used as a guide to drive data collection toward factors that will have the greatest impact rather than blindly collecting data based on subjective decisions.
    - **Help decision-makers communicate more effectively about the system.** A model is a very effective means exchanging ideas because a model is a very explicit collection of components, relationships, and assumptions about the complex system. It is a means of "putting everything out on the table" from the data used to parameterize it, to the methodology used to represent aspects of the system, to the assumptions one needs to make to create the model. Sharing models can lead to iterative improvement and more learned discussion about the system.
    - **Help decision-makers produce evidence base for advocacy.** Models can be an effective means of advocacy. A model can be used to show the benefits, costs, and effort associated with trying to improve a system. It is an evidence-based approach that can make very clear how a change to the system may or may not improve it, and more importantly, to what extent.

5.5 Overall Weaknesses

- **Simplification of a real-world system.** Models are a representation of reality, and therefore can never truly capture every single aspect that could affect a complex decision. Ultimately, building a model requires one to make decisions and assumptions about which factors are important. Different modelers may make different decisions, which is why using multiple models to explore a system and performing iterative improvements based on evolving knowledge can help to gain greater confidence in the results produced.
- **Do not replace human decision-making.** Models can be used as decision support tools, but do not ultimately preclude human decision-making. Models are can help identify the relative effects of

certain scenarios on a system, but since they cannot capture every single factor, they should be a tool, not a crystal ball.

- **Models can vary in transparency and understandability.** As there is a wide range of models, you might have the following issues with some of them:
  - **As some models get more complex, it may become challenging to communicate outcomes.** As models grow more complex, so do the outputs. This can make it challenging to assimilate the results in a meaningful way. Techniques in scientific visualization and data analysis become critical to understanding the output of the models. Additionally, scientific communication becomes key to translating results from modeling to other audiences. Graphical user interfaces and visualization tools can help to automatically present the outcomes in digestible forms.
  - **Some models may require training and expertise to use.** As models grow more complex, the expertise required to create them also increases. Many models require a large number of inputs and may not be written to facilitate naive users to be able to run them. Additionally, few models can be used without some expertise in the system they are meant to represent (e.g. a nurse may not have the required training to parameterize and run an immunization supply chain model). Training is not only important for people who want create and run simulations experiments with the models, but also consumers of modeling output (e.g., decision makers).
  - **Some models may require larger amounts of data as models grow more complex.** As models grow more complex, so do the data requirements for parameterization. Complex models can require a large number of variables, which need to be parameterized or matched to real world data collection. Sensitivity analysis can help to mitigate this and exhibit which factors are most important.

5.6 Profiles of Tools Currently Being Used by USAID

5.6.1 International Futures (IF) Tool

A. **Summary**: International Futures is an illustrative global integrated assessment model designed to help in thinking strategically and systematically across key, country-specific interacting global system areas (economic, demographic, education, health, environment, technology, domestic governance, infrastructure, agriculture, energy and environment).

B. **Tool Description**: IFs represents major agents- classes (households, governments, firms) interacting in a variety of global structures (demographic, economic, social, and environmental). The system draws upon standard approaches to modeling specific issue areas whenever possible, extending those as necessary and integrating them across issue areas. The menu-driven interface of the International Futures software system allows display of results from the base case and from alternative scenarios over time horizons from 2005 up to 2100. [17]

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[17] https://forecasters.org/pdfs/foresight/FSIssue22_pearson.pdf

C. **Tool Features**: Primary outputs of the model include forecasts of any of the variables up to 2100. IF has a data analysis collection of over 2000 data series. Users can analyze data cross-sectionally, longitudinally or on a world map. Using cross-sectional analysis, users can plot up to 5 independent variables. It is then possible to animate the map to see how the cross-sectional relationship changes across the 40+ years of data in the database. A world map allows users to display data from any of these series using GIS options. The software allows users access to change the parameters and variables that are used in the model. Scenario Analysis allows users to create their own global scenario or load one of pre-run global scenarios. This portion of the software allows users to display the forecast results of their scenario analyses for different provinces, countries and groups across different issue areas.

D. **Strengths:** The tool is ready-made, really flexible and powerful if you have the knowledge to properly utilize and analyze the results.

E. **Weaknesses:** The results of the model may be difficult for a lay user to interpret. Users tend to think that the tool is predictive, which is not the case. Rather, it is meant to show magnitude and direction of different outputs.

F. **Examples of past use cases:** The USAID Uganda mission used the International Futures Tools to inform their 5-year strategy. The tool enabled them to set realistic target goals and priorities. The Uganda mission initially wanted to increase GDP to USD $9000 a year. However, IF demonstrated that even if the money is put into multiple sectors (which is unlikely), that goal would not be reached in 20 years. The tool helped the Uganda mission understand the potential magnitude of impact of an intervention, which allowed them to better frame their goals.

In addition to work with USAID, IF has been used to build institutional forecasting capacity and database construction for or with a number of national and international organizations, including[18]:

- Nonprofit organizations: Oxfam America and the SENS Foundation
- Intergovernmental Organizations: The New Partnership for Africa's Development (NEPAD), UN Development Programme, and UN Environment Programme
- Governments: Peru, South Africa's Western Cape Provincial Government, the United States
- Private Sector Entities: Arrow Electrics, General Motors, and Google Public Data Explorer

G. **Resources required**:

Pre-conditions/Goals	**Human Resources**
● Several trips to Uganda to meet with missions and government officials	Staff from Pardee Center

[18] http://pardee.du.edu/research-and-projects

H. **Tool Developer and Availability**: A team at the Joseph Korbel School of International Studies at the University of Denver developed the tool and works around the world to provide long-term integrated analysis of development, security, and sustainability issues. The code underlying IF in both its online and downloadable forms is available, without charge, for anyone to use. [19]

I. **References:**
http://pardee.du.edu/

5.6.2 Causal Loop Diagrams

A. **Summary:** Causal loop diagrams are graphic depictions of the dynamic relationships of factors and parts of a system. CLDs are mostly used prior to simulation analysis to depict the basic causal mechanisms hypothesized to underlie the reference mode of behavior over time.[20]

B. **Tool Description:** When building causal loop diagrams, it is necessary to focus on a specific problem or theme. This helps keep the initial scope narrow and manageable. Then, it is important to identify and list the key variables at play. Variables ought to be precisely named nouns or noun phrases that play a significant role in the issue and represent quantities that can change over time. They can be tangible (the number of residents in a town) and intangible factors (the desire to move to a new town). It can be helpful to involve multiple people with varying views of or roles in the system in question in this stage. This involvement can result in a more comprehensive list of key variables.

Once the initial list of key variables is made, links are made between the variables, using arrows, to demonstrate causation. If A causes a change in B, the arrow originates at A and terminates at B. Arrows must include signs (+) and (-) to represent positive causal links (either A adds to B or a change in A produces a change in B in the same direction) and negative causal links (if either A subtracts from B or a change in A produces a change in B in the opposite direction). Alternatively, arrows can be denoted with "s"s and "o"s. The s stands for "same" and the o stands for "opposite," indicating that the variables at the two ends of the link move in either the same direction or opposite directions. Attention must be paid to how the variables and links relate to the focus of the diagram. If, after all links have been established, there are multiple disconnected groups of variables, this signifies that either variables are missing or some of the variables are not actually important. This step of the process is iterative as unintended consequences are uncovered and variables are added and subtracted.[21]

After establishing all of the links, the diagram is surveyed for loops. The relationships of the variables within the loop are examined, and loops are labeled as "R" for reinforcing or "B" for balancing. Reinforcing loops tend to accelerate movement in a particular direction, the more one variable changes, the more another variables changes. Depending on the nature of impact, they are often referred to virtuous or vicious cycles. Balancing loops seek to bring the state of the

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[19] http://pardee.du.edu/access-ifs
[20] http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.69.8880&rep=rep1&type=pdf
[21] Anderson, V., & Johnson, L. (1997). Systems thinking basics: from concepts to causal loops. Cambridge: Pegasus Communications.

systems to a desired goal. They resist change in one direction by producing change in another direction.

A common occurrence in a complex system is a delayed impact of a change. Though one variable may change, there may be an amount of time that passes before the next variable is affected. It is important to account for these delays because they can make a system's behavior unpredictable and confound our efforts to control the behavior. Delays in impact are represented by a pair of lines (//) or the word delay across the appropriate link.

C. **Tool Features:** Causal loop diagrams include several components:
   - A CLD consists of two or more variables connected by links, which usually take the form of arrows. Causal links should imply direction. A closed circle of variables and links makes up a feedback loop.
   - A feedback loop or a causal loop is a closed sequence of causes and effects that is, a closed path of action and information.
   - Cause-and-effect relationships among the variables
   - Delays

D. **Strengths**: CLDs provide a transparent approach to elucidating black-box systems. The tool forces users to tie in the ends, helping to eliminate misconceptions about the elements involved in the system. Also, building a CLD also requires less quantitative modeling skills. CLDs facilitate focused speculation about how to intervene to redesign or enhance systems. The visual nature of CLDs makes them useful for explaining the complexity of a system to others who may not be familiar with modeling. While there is software available to help with designing CLDs, they can also be created using pencil and paper, making them an accessible tool in all environments.

E. **Weaknesses**: Causal loop diagrams do not distinguish between additive and proportional links. By showing only basic relationships, minor relationships may be excluded and hidden links may have a more important influence of how the system behaves over times.[22] Magnitude of influence between links is not captured in a CLD, leaving it up to the reader or the presenter to assign importance of variables. Even those variables that are connected to many other variables are not guaranteed to be the most important.

F. **Examples of past use cases**: CLDs can be used to start any model building process. USAID has used causal loop diagrams in a number of projects. One recently published example, is the use of a CLD to identify and understand which parts of a system can be leveraged to achieve sustainable development. Below is a CLD they developed:[23]

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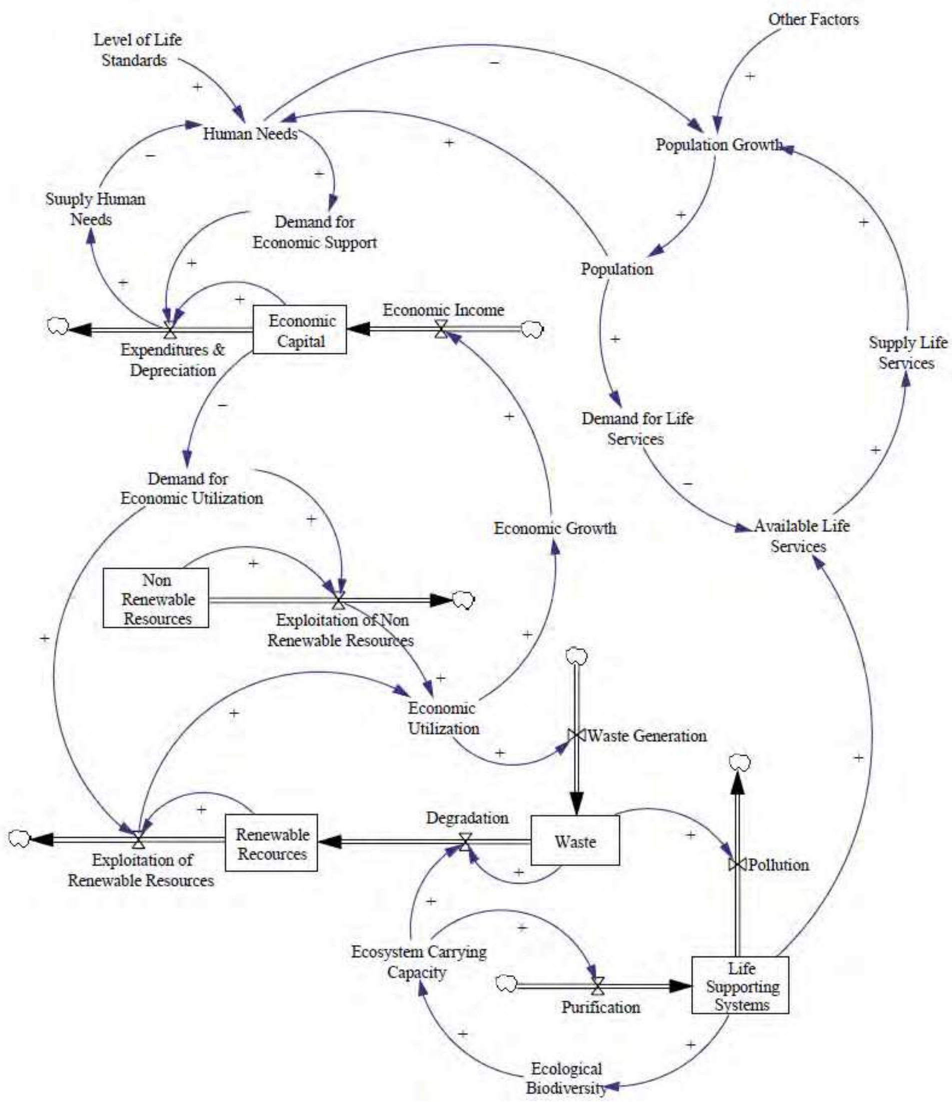
[22] Hürlimann, M. (2009). *Dealing with real-world complexity: Limits, enhancements and new approaches for policy makers*. (Springer - LINK.) Wiesbaden: Betriebswirtschaftlicher Verlag Gabler.
[23] Hjorth, P., & Bagheri, A. (2006). Navigating towards sustainable development: A system dynamics approach. *Futures*, *38*(1), 74-92.



G. Resources required:

Levels	Pre-conditions/Goals	Time	Human Resources
Basic		1 week	Single person
More Complex	Iterative process of creating CLD and discovery of missing variables can add time of the process	Up to 1 month	Committee of people

H. Tool Developer and Availability: As mentioned in the Strengths section, CLDs can be made using pencil and paper. In addition to this, there exist freely available software that can be used to create CLDs such as the free version of the Vensim software.

I. **References**:
http://www.cs.toronto.edu/~sme/SystemsThinking/GuidelinesforDrawingCausalLoopDiagrams.pdf

http://www.anser.org/docs/systems_thinking_applied.pdf

5.7 Profiles of Tools Not Currently Being Used by USAID

5.7.1 HERMES (Highly Extensible Resource for Modeling Event-driven Supply-Chains)

A. **Summary:** HERMES is a software platform that allows users to generate a detailed discrete-event simulation model of supply chain. This simulation model can serve as a "virtual laboratory" for decision makers to address a variety of questions regarding the impact of introducing new technologies, the effects of altering the characteristics of products, how the configuration and the operations of the supply chain affect performance and cost, what the effects of differing conditions and circumstances, may be, how one should invest or allocate resources most effectively, and how product delivery can be optimized. HERMES can work on nearly any personal computer.

B. **Tool Description:** HERMES-generated simulation models include virtual representations of all supply chain locations, shipping routes between locations, storage devices and personnel at locations, vehicles and transport equipment used on routes, different products flowing through the supply chain, demand for these products at each product administration location, and other relevant processes occurring at each location and route. Each of these components can be placed at any location in the network. Each model also includes the shipping and ordering policies that govern operations, as well as any probabilities of shipping delays, to realistically represent any supply chain. A user friendly interface allows users to quickly create and run a simple model with limited data input, add detail and heterogeneity to the model, transform a model to produce new scenarios, and explore results.

C. **Tool Features:** HERMES has the ability to generate discrete-event simulation models of any health product or food supply chain. Users can customize the characteristics of any component in a HERMES model. These characteristics include each product's volume (in and out of packaging), lifetime, required storage conditions, doses per unit, and cost per unit; each storage device's capacity, internal temperature (or other conditions), probability of breakdown or failure, capital cost, maintenance costs, and energy consumption; each vehicle's storage capacity or onboard storage devices, capital cost, maintenance cost, and fuel consumption; each personnel's wages and percent time dedicated to supply chain logistics; and each target population member's required health product or set of products. Every location can be assigned a function (product storage, administration, or both), schedule for administering products, set of geographic coordinates, building capital cost and maintenance costs, and any number of storage devices, vehicles, personnel, and target populations seeking products at the location. Each route that connects two or more locations is assigned a distance, transit time, order of locations visited, mode of transport, probability of delay, per diem policies for drivers and passengers, and ordering policies that determine shipping frequencies and volumes.

While HERMES provides the ability for users to implement nearly any change to a supply chain model, the tool also provides features to automatically perform common tasks. For example, HERMES can perform a gap analysis to identify where storage and transport bottlenecks exist and quantify the additional equipment and shipping frequencies necessary to relieve supply chain constraints. HERMES can also automatically transform a system by replacing point-to-point shipments between two supply chain levels with delivery loops.

D. Strengths: HERMES provides a fully dynamic simulation model of a supply chain. Unlike the majority of current efforts for cold chain and supply chain that are static in nature, HERMES provides a systemic view of the many complex, dynamic interactions taking place within the supply chain.

HERMES provides a complete virtual representation of the supply chain. HERMES can use primary data to measure key metrics at any location, at any time, for any commodity in the supply chain, with minimal investment.

HERMES thoroughly represents the entire supply chain. A HERMES generated model can represent product flow from manufacturer to consumer and provide in-depth measurement across multiple metrics (e.g. equipment, supply chain, transportation, cost, time, wastage).
HERMES generated models are prospective. While it can be used to assess the current state of the public health supply chain, it goes further to assess the future impact of changes in the supply chain system and enable evidence-based decisions for program planning.

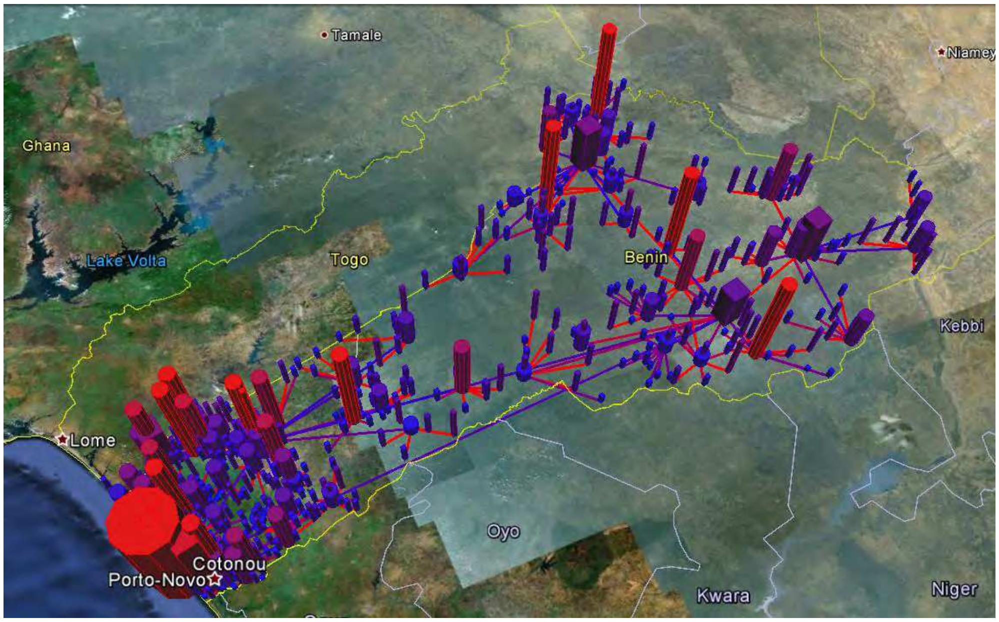
The tool can generate models at varying levels of complexity, so one can start with a simple model that requires only a cursory knowledge of the supply chain system. As more data becomes available, the model can also be increased in complexity.

E. Weaknesses: Building a HERMES generated simulation model of a supply chain can be quite data-intensive. Depending on the question models are being built to address, HERMES can represent a large amount of details pertaining to the system, including all of the storage devices, transportation vehicles, policies, demand, and products.

F. Examples of past use cases:

Country/Project	**Partner Organizations**	**Work**
Niger	Niger Ministry of Health World Health Organization (WHO)	Modeled: • Impact of changing vaccine presentations • Impact of PCV and RV introductions • Impact of system redesign • Impact of thermostable vaccines • Impact of information system
Benin	Benin Ministry of Health LOGIVAC Project (Agence de Médecine Préventive (AMP), WHO) UNICEF PATH	Modeled: •Impact of system redesign Conducted in-country hands-on workshops
Mozambique	Mozambique Ministry of Health VillageReach	Modeled: •Current supply chain performance •Impact of PCV, RV, IPV, MSD, and HPV introductions •Impact of system redesign

		Conducted in-country hands-on workshops
Vaccine supply chain redesign in multiple countries	Bill & Melinda Gates Foundation (BMGF) Co-Chair Meetings	Modeled: •Landscape of all GAVI eligible country supply chains via segmentation analysis •Potential supply chain redesign (simplification) in three sample countries



HERMES-generated visualization depicting maximum storage capacity utilization (red being the highest and blue being the lowest) at different storage locations in the country of Benin.[24]

G. Resources required:

<table>
<tr><th>Levels</th><th>Pre-conditions/Goals</th><th>Time</th><th>Cost</th></tr>
<tr><td>Use existing model</td><td rowspan="3">●Largest component of time and effort involves building initial model of supply chain system
● Dependent on quality of data and level of detail needed to answer questions of interest
● HERMES GUI alleviates many difficulties in model building, data entry, and analysis.
● Cost of model building does not include data collection framework</td><td rowspan="3">Several weeks to several months</td><td>US$ 60,000-120,000</td></tr>
<tr><td>New model/ less complicated</td><td>US$ 150,000-300,000</td></tr>
<tr><td>New model/ complicated</td><td>US$ 300,000-500,000</td></tr>
</table>

24 http://hermes.psc.edu/vision.html

H. Tool Developer and Availability: The HERMES software is developed by the HERMES Logistics Modeling Team which is a collaboration between the Johns Hopkins Bloomberg School of Public Health and the Pittsburgh Supercomputing Center at Carnegie Mellon University. The software is licensed under the Affero GPL v 3.0 open source license. The software can be obtained free of charge by contacting the HERMES Logistics Modeling Team, with details on how to contact them given on their website (http://hermes.psc.edu).

J. References:

Lee BY, Connor DL, Wateska AR, Norman BA, Rajgopal J, Cakouros BE, Chen S, Claypool EG, Haidari LA, Karir V, Leonard J, Mueller LE, Paul P, Schmitz MM, Welling JS, Weng Y, Brown ST. (2015) Landscaping the structures of GAVI country vaccine supply chains and testing the effects of radical redesign. Vaccine, 33(36):4451-8.
http://dx.doi.org/10.1016/j.vaccine.2015.07.033

Lee BY, Schreiber B, Wateska AR, Connor DL, Dicko HM, Jaillard P, Mvundura M, Levin C, Avella M, Haidari LA, Brown ST. (2015) The Benin experience: How computational modeling can assist major vaccine policy changes in low and middle income countries. Vaccine, 33(25):2858-61.
http://dx.doi.org/10.1016/j.vaccine.2015.04.022

Haidari LA, Wahl B, Brown ST, Privor-Dumm L, Wallman-Stokes C, Gorham K, Connor DL, Wateska AR, Schriber B, Dicko H, Jaillard P, Avella M, Lee BY. (2015) One size does not fit all: The impact of primary vaccine container size on vaccine distribution and delivery. Vaccine, 33(28):3242-7.
http://dx.doi.org/10.1016/j.vaccine.2015.04.018

Brown ST, Schreiber B, Cakouros BE, Wateska AR, Dicko HM, Connor DL, Jaillard P, Mvundura M, Norman BA, Levin C, Rajgopal J, Avella M, Lebrun C, Claypool E, Paul P, Lee BY. (2014) The benefits of redesigning Benin's vaccine supply chain. Vaccine, 32(32):4097-103.
http://dx.doi.org/10.1016/j.vaccine.2014.04.090

Website: hermes.psc.edu

5.7.2 RHEA

A. Summary: The Regional Healthcare Ecosystem Analyst (RHEA) tool is a software platform which can generate an agent-based model (ABM) that represents all of the different facilities in a region and the people moving amongst and within the different facilities.

B. Tool Description: The tool ingests data from a common spreadsheet format. The RHEA tool can ingest a range of standard data inputs from any network of locations and rapidly create an ABM of that system. The detail of the input data will determine the detail of the resulting ABM. The ABM is a virtual re-creation of the relevant ecosystem (ie., healthcare, political, agricultural, education) and comprises multiple integrated model components including economic and operational functions to understand the movement of people or other things between locations in a region.

C. Tool Features: RHEA is being designed to assess the value of cooperation among facilities in approaching issues such as the introduction of new technologies, the effects of altering characteristics of the technologies, understanding how configurations of facilities impact performance and cost, the effects of different conditions and circumstances and the most cost-effective way to allocate resources. RHEA uses a range of data inputs including characteristics of the facilities (ie., schools, hospitals or farms), characteristics of virtual information/people/products and the way that the transfer of information/people/products occurs. The model is run on a daily time-step and movement between facilities or between a facility and the community is based on conditional probabilities. RHEA allows for a full-year tracking of individuals.

D. Strengths: Standard data inputs are rapidly ingested to create a simulation model of any system, reducing time and costs involved in building bespoke simulation models. The integration of multiple model components allows users to visualize the movement of information/people/products and assess a variety of issues. The model is being developed with the end-user in mind, i.e. a user-friendly interface accessible to a range of decision makers and health officials.

E. Weaknesses: The tool is not yet available for interventions at the individual patient- and employee-level. As the tool is further developed, these capabilities will be possible.

F. Examples of past cases: Orange County, CA: Regional healthcare ecosystem was created using de-identified data from state and national databases. The model was calibrated using MRSA incidence and prevalence data. Users could assess the role of the healthcare network in sustaining MRSA spread in the community, and used the tool to simulate multiple interventions and experiments in a virtual environment.

G. Resources required:

<table>
<tr><th>Levels</th><th>Pre-conditions/Goals</th><th>Time</th><th>Cost</th></tr>
<tr><td>Use existing model</td><td rowspan="3">●Largest component of time and effort involves building initial model of the ecosystem of interest
● Dependent on quality of data and level of detail needed to answer questions of interest
● Cost of model building does not include data collection framework</td><td rowspan="3">Several weeks to several months</td><td>US$ 60,000-120,000</td></tr>
<tr><td>New model/ less complicated</td><td>US$ 150,000-300,000</td></tr>
<tr><td>New model/ complicated</td><td>US$ 300,000-500,000</td></tr>
</table>

H. Tool Developer and Availability: The tool is currently in development for general use, but has not been made available.

I. Sources:

1. Lee, Bruce Y, et al. "The Regional Healthcare Ecosystem Analyst (Rhea): A Simulation Modeling Tool to Assist Infectious Disease Control in a Health System." Journal of the American Medical Informatics Association 20.e1 (2013): e139-e46. Print.
2. http://grantome.com/grant/NIH/R01-HS023317-01

5.7.3 JANUS

A. **Summary:** JANUS Decision Support is a computational platform that can layer policies and interventions on top of each other within a defined geographic region to see the interactions and combined impact of different intervention portfolios.

B. **Tool Description:** The user enters the JANUS Decision Support tool and then chooses to either open a previously constructed scenario and intervention portfolios or create a new scenario and intervention portfolios. To create a new scenario, the user walks through a series of screens that allow him or her to select a location of interest, review and modify characteristics of the location, select interventions and their implementation characteristics to create intervention portfolios, and review and modify product or intervention characteristics. The model generates results on a variety of user-selected outcome measures. The user can then compare different portfolios of interventions in the chosen location (e.g., differences in disease and economic impact). Results can be stored in the JANUS Library to be accessed at a later time.

C. **Tool Features:** The JANUS Decision Support platform brings together multiple integrated innovations and allows the user to combine product/intervention development with portfolio management. This is valuable because the ideal characteristics for a product/intervention depend on the setting and the other available interventions. It also systematically optimizes product/intervention development and implementation over a variety of user selected outcome measures. Since each product/intervention has a constellation of characteristics that interact with each other and with those of other products/interventions, finding the best combination can be challenging and time-consuming. Moreover, the optimal set of characteristics depends on the measures of interest. It also evaluates product design and portfolios over multiple outcome measures and perspectives. JANUS provides a user-friendly platform to explore the effects of using different transmission models. It also places intervention portfolio and development evaluation capabilities directly in the hands of decision makers.

D. **Strengths:** Many interventions and strategies affect various economic, epidemiologic, and clinical measures in different ways for different stakeholders. Showing how policies and interventions may affect different stakeholders can help find mutually beneficial situations and help with advocacy. The platform uses a standardized interface for inputs and outputs but also is flexible enough for future expansion. Furthermore, not all transmission models calculate output measures interesting to policy makers. In such cases JANUS DS can use available data to fill in these gaps, providing a common basis for comparison across model predictions. JANUS aims to empower decision makers to engage the models themselves rather than rely on modelers to provide black-box answers, reminiscent of the way spreadsheets like Microsoft Excel have empowered “lay people” to do financial analyses and explore different financial models. This approach generally results in faster adoption and greater trust in the results. The JANUS support team will work closely with key initial stakeholders to ensure that their needs are met in a manner that provides the best user experience and understanding.

E. **Weaknesses:** While this is a useful tool to aid decision making, it ultimately does not replace human decisions. Results of JANUS can also be susceptible to misinterpretation; they are not predictions of the future, rather, they provide relative quantifications of relationships to identify the most important variables and factors in the system. Currently the model focuses on disease transmission, though it can be adapted to a variety of other domains (ie. education policy, technology, agriculture etc.)

F. **Examples of past cases:** JANUS evaluated the financial, clinical and epidemiologic impact of different malaria interventions: bed nets and sprays. JANUS determined that increasing coverage of either nets or sprays is always cost-effective and that in some cases, increasing coverage of nets would be cost-saving, however results vary by region reflecting differences in malaria transmission, seasonality, current/historic interventions, and resistance patterns and levels. Between sprays and nets, nets are usually better except when net usage is low. With constrained resources it is imperative to get a handle on net usage rates as this is a major variable that impacts the value and effectiveness of net campaigns.

G. **Resources required:**

Levels	Cost
Use existing model	US$ 60,000-120,000
New model/ less complicated	US$ 150,000-300,000
New model/ complicated	US$ 300,000-500,000

H. **Tool Developer and Availability:** JANUS was developed by the Johns Hopkins Bloomberg School of Public Health and the Pittsburgh Supercomputing Center.

I. **Sources**: http://www.globalobesity.org/

5.7.4 TreeAge

A. **Summary**: TreeAge is modeling software designed to implement the techniques of decision analysis in an intuitive and easy to use manner, allowing users to build and analyze trees to study any kind of problem.

B. **Tool Description:** TreeAge transforms decision analysis from a potentially tedious exercise into an easily applied and highly visual means of organizing the decision making process, analyzing the problem at hand and communicating the structure of the problem, the nature of the uncertainties, and the basis for a strategy recommendation. Building a decision tree involves the following principles. In the tree, events are ordered from left to right. The tree often follows a time ordering of events, as outcomes become known to the decision maker. Different kinds of events are distinguished using shapes called “nodes.” A decision node (square) indicates a choice facing the decision maker. A chance node (circle) represents an event which has multiple possible outcomes and is not under the decision maker’s control. A terminal node (triangle) denotes the endpoint of a scenario. Branches “sprouting” from a decision node represent the set of actions being considered. Branches from a chance node represent the set of possible outcomes of the event. The branches must be mutually exclusive and exhaustive — in other words, defined such that all possibilities are covered and none overlap. Their probabilities must sum to 1.0 (100%). Terminal nodes are assigned a value, referred to generically as a payoff.[25]

C. **Tool Features:** TreeAge can explore a variety of different outputs. The choice of calculation method determines the formula used to calculate values for nodes in your tree. There are three main kinds of calculation methods: Simple, single-attribute calculations; Multiple-attribute calculations, including: Benefit-Cost and Multi-Attribute (weighted); and healthcare module users can use a third form of multi-attribute calculations, Cost-Effectiveness. Simple calculations are just that — expected values are calculated for the nodes in the tree based simply on the values in the active payoff set. If, as described above, your tree included multiple attributes — such as monetary benefits in payoff #1 and costs in payoff #2 — the two sets of payoff values could be combined in a single calculation using the Benefit-Cost calculation method's formula.

D. **Strengths:** TreeAge is an available, pre-programmed package, with the flexibility to analyze any issue involving a decision process. The software is intuitive and user-friendly.

E. **Weaknesses:** TreeAge provides a simplified breakdown to analyze a decision and does not characterize nor captures all of the dimensions of an issue. As the decision is often broken down mechanistically, there may not be data for every node in the tree, requiring extensive sensitivity analyses to minimize effects of using estimates to determine relative impacts of the variables. Some may find large models and/or equations to be unwieldy.

F. **Examples of past cases:** TreeAge software has been used in many industries including healthcare, legal, oil and gas exploration, teaching, etc. The software has been used all over the world, including the US, Europe, Latin America, Asia, Australia and Africa.

A TreeAge model was used during the most recent outbreak of Ebola virus disease (EVD). The tree was utilized to understand the cost of a case of Ebola. The model estimated the cost of an EVD case from the provider and societal perspectives in the three most affected countries of Guinea, Liberia, and Sierra Leone. The model estimates the total societal cost of an EVD case with full recovery ranges from USD $480 to USD $912, while that of an EVD case not surviving ranges from USD $5929 to USD $18 929, varying by age and country. Therefore, as of 10 December 2014, the estimated total societal costs of all reported EVD cases in these three countries range from USD $82 to potentially over USD $356 million.[26]

G. **Resources required:**

Levels	**Cost**
Use existing model	US$ 60,000-120,000
New model/ less complicated	US$ 150,000-300,000
New model/ complicated	US$ 300,000-500,000

[25] Pro, T. (2009). Treeage Pro User's Manual. *Williamstown, USA*.
[26] Excerpt Bartsch, S. M., Gorham, K., & Lee, B. Y. (2015). The cost of an Ebola case. *Pathogens and global health*, *109*(1), 4-9.

H. **Tool Developer and Availability:** TreeAge Software Inc. is a privately held company that has been developing decision analysis software for over 20 years. TreeAge licenses are publicly available to purchase.

I. **Sources:** https://www.treeage.com/

5.8 Identified Gaps

After investigating the current landscape of Modeling tools utilized at USAID, there appears to be a gap in understanding the complexity of systems related to development, limited awareness and access to modeling platforms, limited understanding of the added-value of modeling and limited expertise with modeling tools.

While there is a desire and a need for systems science thinking, the complexity of systems related to international development is not well understood. Without an understanding of the complexity of the system, it is challenging to accurately quantify the impact of policies and interventions. Missions typically report on static metrics to demonstrate the impact of the intervention, which often oversimplifies and misrepresents the impact of a program or activity. A single metric or even a set of metrics often fail to account for underlying breakdowns or hidden relationships in a system.

Furthermore, there seems to be a lack of awareness and access to modeling platforms geared towards development. As modeling is relatively newer to the development sphere, there are only a handful of models that have been applied to issues related to development. Even fewer have been employed by USAID missions. In fact, based on interview of a sample of USAID staff, our investigation of modeling tools found International Futures and Causal Loop Diagrams to be the only known modeling tool used by USAID. Most missions are likely unaware of other modeling tools.

Lastly, there is limited expertise on how to use models. Even if there was greater awareness of modeling tools, there is a gap in those feeling qualified to build, use and analyze results from models. Many believe models require great technical knowledge and training to begin to benefit from the results. As missions have limited time, money and resources there are constraints to integrating such approaches with set activities. The perceived barriers regarding required expertise are often much greater than the actual required expertise for modeling.

5.9 Recommendations

In order to address the gaps mentioned above, it is necessary to demonstrate the added-value of computational simulation modeling. What can missions gain from utilizing modeling? The added-value largely revolves around models' ability to illuminate the black-box of systems. By understanding and testing how a system operates under a range of conditions, users can be proactive in their policies and interventions, rather than reactive. The *Overall Strengths* section of *Visualization Approaches (Modeling)* (pg. 28) outlines added-value of modeling in greater detail. Effectively communicating this information to missions is an important piece of encouraging the use of modeling.

As missions begin to understand the value of modeling, they will be more interested in opportunities that facilitate modeling key systems related to their program. Creating and advertising opportunities will increase awareness of modeling platforms among missions which is essential to the adoption of modeling.

It is also important for USAID missions to feel supported and properly equipped when they begin the modeling process. When integrating computational simulation modeling, it is important to iteratively build the model in partnership with the mission. It is often useful to start by building a causal loop diagram, which requires less technical modeling skills, and provides a visualization of the dynamic interrelationships of important variables in a system. Information from causal loop diagrams can then feed into further development of a model.

Additionally, it is necessary to provide trainings regarding model use and analysis. As different models are useful for different types of questions, it is important to use the right type of model, thus it is beneficial to involve experts to guide this process. Previous trainings on how to use models, demonstrated that little to no experience with software platforms is required to learn how to build, enter data and understand the outputs of the model. For example, a workshop conducted on the HERMES model in Niger trained multiple personnel with limited knowledge on modeling, how to upload data and get results from the model within a day of being introduced to the software.

6. NARRATIVE BASED APPROACHES

6.1 Definition

Narratives are collections of assumptions, beliefs, phenomena, outcomes, and mindsets that people use to make sense of the world. They help users understand complex systems, often through the eyes and perspectives of key system stakeholders. Composed of "language and metaphors…[narratives] are attractors around which whole systems organize; [they are] part of the 'glue' that connects multiple levels of a system and also the 'grease' that makes the system run."[27]

Narrative systems tools are those tools that utilize descriptive inputs to capture key system features, including actors, interactions, resources, and outcomes.[28] They are unique in their ability to integrate a variety of perspectives to interpret and analyze a complex, dynamic system. Moreover, narrative tools help users capture system changes over time to measure the likely past and future impacts of system interventions.[29] Some narrative tools are constructed by eliciting the perspectives of system stakeholders. In such instances, the tools represent varying perspectives on the nature of complex challenges as well as the method of addressing those challenges. Alternatively, narratives offer a way to aggregate data deriving from expert sources, literature, and other data to illuminate the dynamic nature of systems in ways particularly suited to decision making.

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[27] Dynamical Systems Innovation Lab. "Non-Linear Impact Assessment: Challenges, Approaches and Tools." (2014). Web. 25 January 2016.
<https://conflictinnovationlab.files.wordpress.com/2014/03/impact_eval_draft_briefing_paper_16jul2014.pdf>.
[28] U.S. Agency for International Development. "Measuring Systems Change: USAID's Current Thinking." (2015). Web. 25 January 2016. USAID Learning Lab.
<http://usaidlearninglab.org/sites/default/files/resource/files/systems_and_capacity_usaid.pdf>.
[29] Dynamical Systems Innovation Lab 2014.

Narrative tools are especially useful in systems with "random, unorganized, or unknown system dynamics," meaning "there are no clear patterns of interaction between system parts or actors, and no clear understanding of how to move forward."[30] Moreover, these tools are useful in evaluating complex systems at very different scales, from small communities to whole regions. This is due to the fact that narrative tools can be applied to a very direct, narrow focus, such as small focus groups, or used to examine the perceptions of society at large, for example through country-level surveys. Technological advances have further enabled this large-scale sourcing of narratives for system-wide analysis.[31]

6.2 Subcategorization of Narrative Tools

A variety of narrative-based systems tools are in use both within and outside of USAID. Diverse with regard to their inputs, their outputs, and their method for organizing data, these tools may be categorized along a variety of spectra, which helps in selecting from among the many options available:

Data-gathering methodology: Data-gathering methods that support the use of narrative systems tools can differ in approach. Bingley (2014) explores the practice of distinguishing research methods or tools by data-gathering approaches. In international development specifically, she notes that the nature of "participative" approaches that engage stakeholders in the process of generating data differs from initiatives that are "analytic (defined as desk-based research and analysis by an individual or group)."[32] On one end of the data-gathering spectrum lie experiential approaches that source ideas, personal experience, opinions, and observations from a range of individuals to weave together narratives constructed from the perspectives of stakeholders. For example, Scenario Planning (described on pg. 58) is among those many tools that draw from stakeholder perspectives to produce narratives. At the other end of the spectrum exists expert-written, data-driven approaches in which the users of a tool may source information from a variety of evidence-based publications or data sets. For instance, the Innovation System Analysis (described on pg. 64), assembles a wide range of data points on the actors and phenomena that make up the innovation system, which may be sourced from academic literature or published studies (e.g., OECD National Innovation System series). Further, researchers at the International Institute for Impact Evaluation consider the value in specifying the degree for which data gathered for narrative tools is integrated, specifying the distinction between "aggregative" versus "interpretive" approaches.[33]

Time Orientation: Narratives are necessarily descriptive of a context and a time frame. They may be oriented toward the past, the present, or even the future. These three temporal perspectives serve as a helpful way to parse the universe of narrative-based tools. For example, Scenario Planning is among many Strategic Foresight tools that use narratives to frame and depict the future, thereby helping users grapple with uncertainty about systems and with how systems might change over time. By contrast, tools such as

[30] Hargreaves, Margaret B. (2010). "Evaluating System Change: A Planning Guide." Mathematica Policy Research, Inc. <http://www.mathematica-mpr.com/~/media/publications/PDFs/health/eval_system_change_methodbr.pdf>.
[31] Dynamical Systems Innovation Lab, 2014.
[32] Bingley, K. (2014). A Review of Strategic Foresight in International Development. Evidence Report. *Policy Anticipation, Evaluation and Response*. No 94.
[33] Birte Snilstveit, Sandy Oliver & Martina Vojtkova (2012). Narrative approaches to systematic review and synthesis of evidence for international development policy and practice. Journal of Development Effectiveness, 4:3, 409-429, DOI: 10.1080/19439342.2012.710641.

Outcome Harvesting gather stakeholder perspectives that describe both the past and the present to demonstrate how a situation has changed, or what "outcomes" have been achieved within the scope of a system intervention. Kalvo-oja (2006) explores how different tool types may be used in different sequences according to user interest in exploring the future, making sense of the past, or informing the present.[34] Thus, beyond offering a method for categorizing tools, one can consider possible sequences of tool use according to each tool's time orientation. With regard to the comparative importance between systems tools' time orientation, the author further explains, "systems thinking requires the ability to synthesize or integrate elements rather than breaking them into parts for the purpose of analysis. That is why we should pay attention to potential roles of foresight [one field of futures-focused tools] in relation to innovation process" in particular.[35]

<u>Evaluative versus descriptive:</u> Systems tools may also be categorized according to the purpose of the resulting narrative. Tools aim (1) to evaluate successes and failures in a given system, or (2) to describe and interpret the actors and interactions that compose a given system. Affirmed by McClintock (2004) among other scholars, the distinction between evaluative and descriptive tools allows users to hone in on the purpose that guides their tool selection.[36] For example, a user seeking to measure system change against various benchmarks or project targets may choose an evaluative tool such as Most Significant Change (discussed further on pg. 53), Outcome Harvesting (discussed further on pg. 56) or the Success Case Method, a tool that gathers narratives about positive and negative outcomes.[37] Such tools might prove useful in later stages of a program cycle, to evaluate whether or not a completed program was successful. Alternatively, descriptive narrative tools including the Innovation System Analysis (discussed further on pg. 64) and Scenario Planning (discussed further on pg. 58) do not measure system change against specific targets or milestones, but may be used to optimize the earlier stages of program design and development by offering robust systems descriptions.

6.3 **Uses and Types of Questions that Can Be Addressed**

Narrative-based tools can be used to help development practitioners and decision makers answer key questions throughout the program cycle. The steps of the USAID program cycle follow, augmented with key questions that may be answered by employing narrative-based systems tools:

Country Development and Cooperation Strategies
At the beginning of the program cycle, narrative-based tools can help users answer questions pertinent to the problem at hand (e.g., food insecurity in a particular country or infant mortality within a certain population), such as:
"What is the current state of the problem we are trying to solve?"
"What are the many pieces of this complex problem, and how do they fit together?"
"What is the broader system context surrounding the problem?"

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[34] Kaivo-Oja, J. (2006). Toward Integration of Innovation Systems and Foresight Research in Firms and Organizations." Finland Futures Research Centre. FFRC Publication 2/2006.
[35] Kalvo-oja 2006.
[36] McClintock, C. (2004). "Using Narrative Methods to Link Program Evaluation and Organization Development." The Evaluation Exchange. Harvard Family Research Project, Harvard Graduate School of Education. 2003/2004.
[37] Brinkerhoff, R. (2003). The Success Case Method: Find out Quickly What's Working and What's Not. Berrett-Koehler Publishers.

Project Design and Implementation
Narrative-based tools can help users better design their project by answering questions such as:
"What is the best method for intervention?"
"Who are the key actors who have the ability and willingness to take action on this problem?"

Narrative-based tools can help users better implement their project by answering questions such as:
"What factors might serve to either enable or hinder this approach?"
"What features of the system enable or thwart innovation aimed at this problem?"

Monitoring
In the Monitoring phase of the program cycle, narrative-based tools can be particularly useful in helping answer questions such as:
"What changes (if any) have the many stakeholder groups observed?"
"How are the system actors and interactions shifting over time?"
"How do our intended beneficiaries feel about the state of the problem?"
"Are stakeholders observing changes within a system that were not intended?"

Evaluation
In the Evaluation phase of the program cycle, narrative-based tools can be particularly useful in helping answer questions such as:
"How closely did our activities match to stakeholders' voiced needs?"
"How might we adjust our activity design to better meet stakeholder needs?"
"How have stakeholder emotions, beliefs, biases, judgments, etc. shifted over the course of the intervention?"

Learning and Adapting
In this final phase of the program cycle, narrative-based tools can help practitioners answer questions such as:
"Where in the system did innovation deliver solutions to address the problem at hand?
"How might we optimize innovation impact to design better interventions going forward?"
"What indicators of systems change can we identify to adapt and attune our programs to the future?"
"What aspects of system change were unexpected or unintended, and how can we use those learnings to adjust our future monitoring and evaluation?"

6.4 Overall Strengths

A number of strengths illustrate the power and benefit of integrating narrative-based tools into monitoring and evaluation approaches. Five of these strengths are noted below.

Contend with complexity in a way that more traditional M&E approaches cannot
When analyzing the differences between the categories of systems and complexity tools reviewed in this White Paper, one can find an "inherent tension between indicator-based monitoring and complexity: indicators are based on what we expect might change, but complex aspects of a situation make it difficult to predict what will change and how…[therefore, indicator-based tools] may need to be supplemented by

more open-ended inquiry with a range of stakeholders."[38] Thus, narrative-based systems and complexity tools are uniquely valuable in their ability to describe and analyze the many facets of complex systems in a way that more quantitative methods cannot.

Support participatory approaches to development
By sourcing and analyzing narratives, users can adopt a more participatory approach to development. Through tools like Most Significant Change, SenseMaker, and Outcomes Harvesting, users engage meaningfully with stakeholders such that their opinions and experiences can both shape program evaluation and allow for adaptive management to ensure programs better meet those stakeholders' needs. Moreover, sourcing and analyzing narratives is well-suited to diverse, complex programs that involve many stakeholder groups and multiple funders. That narrative-based tools typically feed cleanly into organizations' structures for planning, evaluation, and decision making only adds to their list of strengths.[39]

Possess a high level of utility
Monitoring and evaluation is not only useful at the level of an activity or project; rather, M&E data is often used to support high-level, organizational decision making. As such, the value of M&E data is only useful if its meaning and its analysis are well understood. While computational models and methods can be quite difficult for high-level decision makers to fully analyze, it is often much easier to translate the intent of narrative-based tools into insights that are accessible to decision makers. Thus, narrative-based tools boast a level of accessibility to individuals in all organizational levels and/or departments, fueling their broader uptake and impact.

Validate key voices that speak to systems change
As stories and storytelling have continued to gain credence as methods for assessing international development systems, narrative-based tools have elicited increased recognition for their ability to validate stakeholder voices. Tools that help users hear stakeholders' voices and organize their perspectives so as to see patterns within systems facilitate deeper systems thinking and enhanced systems-based decision-making. As the recognition of these valuable methods grows, international development practitioners acknowledge that quantitative and computational models and approaches paint an incomplete picture of complex systems if used without the richness afforded by stakeholder participation, which so many narrative tools offer.

Express systems features that cannot be understood by modeling alone
In terms of the benefits of narrative tools, they differ according to category (e.g., Time Orientation, Evaluative versus Descriptive, etc.) as well as the degree to which the tool selected matches to the purpose intended by the user. With respect to narrative tools that source information from stakeholder discourse, these often offer the benefit of highlighting attitudes, beliefs, biases, and shared knowledge. These stakeholder-centered system elements may allow for the examination of the emotions behind them, an often-neglected consideration in more data-driven approaches to systems research.[40] Furthermore, an

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[38] Dynamical Systems Innovation Lab, 2014.
[39] J.J. Dart, R.J. Davies. "A dialogical story-based evaluation tool: The Most Significant Change technique." *American Journal of Evaluation*, 24 (2003), pp. 137–155.
[40] *Ibid*.

abundance of systems researchers, including Checkland and McDermott, note the necessity of using narrative approaches to express problems, issues, and opportunities that are poorly understood by computational models alone.[41]

6.5 Overall Weaknesses

Like all tools, narrative-based tools present certain weaknesses, four of which follow. However, with care and attention these weaknesses can be overcome. Importantly, no single tool perfectly assures systems- and complexity-awareness in performing monitoring and evaluation. Rather, many of these weaknesses are readily addressed by matching various systems tools and methods together to assure a comprehensive, useful, and feasible approach to systems-based work.

Challenges with quality control

Quality control can be harder when sourcing narrative viewpoints or experiences than it is when gathering more quantitative data. Moreover, the process of verifying personal viewpoints can be complicated as well as time-consuming. Verification is sometimes impossible, especially when one adopts a vantage point from which all stakeholder perspectives are valid and therefore cannot be "right" or "wrong." Furthermore, narrative tools can vary widely in their methods of data collection and analysis, and ensuring a level of rigor and consistency is critical for a thorough evaluation of system-wide features.

Perceived supremacy of numbers over words

Today's largely Western-dominated research culture values research in which hypotheses are supported with facts and figures. The prevailing assumption, therefore, is that numbers are more important and narratives are less valuable, which can limit the use / uptake of narrative-based tools. Combining narrative-based tools with more quantitative indicator-based tools and/or visual tools can help address this issue by adding a more fact-based, quality-controlled element to the monitoring and evaluation endeavor.

Time- and human resource-intensive

Using participatory approaches that source stakeholder perspectives takes a time and labor. Sourcing narratives can be quite difficult, especially when stakeholders reside in remote areas and must be interviewed in person.

Potentially perceived as extractive

Narrative-based tools can rely on extracting sensitive information from stakeholders. Moreover, methods of data-gathering often require those stakeholders to willingly give their time, which could otherwise be used performing their work, taking care of their children, etc. Thus, users of narrative-based tools as with any monitoring and evaluation tool must take caution when asking beneficiaries to engage with those tools.

6.6 Profiles of Tools Currently Being Used by USAID

6.6.1 Commercial, Legal, and Institutional Reform (CLIR)

A. **Summary:** The Commercial, Legal, and Institutional Reform (CLIR) diagnostic, developed by Booz Allen Hamilton, is a framework used to analyze a country's commercial law regime and the

[41] McDermott, Tom. (2014). "Soft Systems Approaches for Constructing Complex System Models."

implementing institutions, supporting institutions, and social dynamics that either enable or disable trade and investment.[42] In response to requests from USAID missions, CLIR has been adapted to other sectors or issues beyond the original focus on business enabling environment that the BizCLIR assessment provided.[43] These include agriculture (AgCLIR), health (HealthCLIR), gender (GenderCLIR), and the performance of specific value chains (MicroCLIR).[44] The insights derived from the CLIR diagnostic can be used for a variety of purposes: as a foundation for policy development, a framework for donor intervention, a substantive resource for future projects, a benchmark for assessing change, a tool for academic instruction, and a "jumping off point" for stakeholder discussion and consensus-building.[45]

B. **Tool Description:** The CLIR Assessment is carried out by a team of researchers who conduct in-depth secondary research on the four CLIR dimensions and specific key issues relevant to the topic of interest. This initial research is followed by in-person interviews with numerous government officials, NGOs, multilateral and bilateral donor representatives, and other stakeholders relevant to the topic to assess the CLIR environment in a selected country.[46]

The resulting product is a written analysis identifying specific areas where reforms are needed, as well as a set of scores based on the interview questions and chosen indicators that capture the status of the CLIR environment. While the scoring tool does not provide a scientific, statistically "correct" grade, the scoring helps to ensure integrity and discipline in a highly qualitative process, similar to the World Bank's *Doing Business* report.[47]

While the tool can be adapted to address various topics, CLIR examines each topic across four dimensions: the legal framework, implementing institutions, supporting institutions, and social dynamics. Specific indicators of relevance to the topic are selected, such as Company Law or Commercial Dispute Resolution in the case of the original CLIR assessment, or Women's Role in Society and Women and Criminal Justice key issues, which feature in the GenderCLIR diagnostic.[48]

C. **Tool Features:** The CLIR diagnostic was originally designed to help USAID missions develop a factual basis for determining the degree of development of a country's private sector, the status of commercial law reforms in a country, and the root causes of gaps in implementation or enforcement of reforms. These insights aimed to inform new approaches to sustainable, cost-

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[42] Macedonia Corporate Governance & Company Law Project. "Macedonia: Moving in the Right Direction. A Report on Progress and New Priorities in Commercial Law and Institutional Reform Since July 2000" (2003). USAID. <http://pdf.usaid.gov/pdf_docs/Pnadb731.pdf>.
[43] Booz Allen Hamilton. "Business Climate Legal and Institutional Reform: BizCLIR Project Final Report." (2011). USAID. <http://pdf.usaid.gov/pdf_docs/PA00K6QW.pdf>.
[44] Microlinks. "Tools and Resources: MicroCLIR." USAID. <https://www.microlinks.org/good-practice-center/value-chain-wiki/climate-legal-and-institutional-reform-tools-clir>.
[45] Fintrac Inc. "AgCLIR Myanmar." (2014). USAID. <http://eatproject.org/docs/EATAgCLIRMyanmarExecweb.pdf>
[46] *Ibid.*
[47] Macedonia Corporate Governance & Company Law Project.
[48] Booz Allen Hamilton 2011.

effective interventions addressing commercial, legal, and institutional reform in a chosen country, thereby offering a more system-wide lens.[49]

D. Strengths: The CLIR diagnostic is versatile in that it can be tailored to specific sectors. In addition, the time required to conduct a CLIR assessment is relatively short, as an assessment team can be on the ground within 6-8 weeks of initiating the project, spend 2-3 weeks in-country conducting interviews, and submit the final report for approval within 6-8 weeks of the team's return.[50] CLIR also offers different levels of depth in research, which can be customized to meet budget and time constraints of the project.[51] Based on an evaluation of the USAID-funded BizCLIR project, ninety-two percent of respondents suggested that the BizCLIR assessments were useful.[52]

E. Weaknesses: Challenges identified with CLIR pertain to the resources needed to run the assessment. With a smaller team, limits to stakeholder engagement likely reduce the comprehensiveness of the data elicited. Similarly, trade-offs between breadth versus depth in the research performed impact the rigor of the results and the comprehensive nature, or lack thereof, of the system-wide view.

F. Examples of past use cases: Beginning in 1998, there have been numerous instances of use of the CLIR diagnostic by USAID missions and on specific programs, such as Feed the Future. From 1998 to 2006, USAID implemented a CLIR assessment to analyze specific commercial and trade laws that affected trade and investment. Between 2006 and 2010, USAID funded the BizCLIR project that was designed to examine the overall business enabling environment of a country or region. In addition, the BizCLIR project responded to specific requests from USAID missions to develop variations of the tool to be used in different sectors and themes beyond its original private sector focus.[53]

From December 2006 to November 2010, the BizCLIR Project conducted 25 assessments in 20 countries and regions around the globe, in addition to specialized studies for 11 Missions on issues that included infrastructure assessments, an analysis of Kenya's mobile financial services sector, and an analysis of the role and importance of Shariah law in Afghanistan.[54] The popularity of these assessments derived from their ability to provide expert analysis, concrete recommendations, and instant impact within a short period of time and without taxing mission resources due to the relatively simple process of buying into the project without submitting a new task order.

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[49] Booz Allen Hamilton. "Commercial Legal and Institutional Reform Assessment: Diagnostic Assessment Report for Kosovo." (2004). USAID. <http://pdf.usaid.gov/pdf_docs/pnade547.pdf>
[50] *Ibid*.
[51] AMEX International. "Evaluation of USAID BIZCLIR Program" (2011). <http://pdf.usaid.gov/pdf_docs/Pdact328.pdf>
[52] *Ibid.*
[53] *Ibid.*
[54] Booz Allen Hamilton 2011.

G. Resources Required:

Time	Human Resources	Cost
14-20 weeks	Hiring of researchers and subject matter experts, travel, and other costs[55]	US$ 250,000-500,000

H. Tool Developer & Availability: Booz Allen Hamilton is the developer of the CLIR diagnostic.

I. References:

Macedonia Corporate Governance & Company Law Project. “Macedonia: Moving in the Right Direction. A Report on Progress and New Priorities in Commercial Law and Institutional Reform Since July 2000” (2003). USAID. <http://pdf.usaid.gov/pdf_docs/Pnadb731.pdf>.

Booz Allen Hamilton. “Business Climate Legal and Institutional Reform: BizCLIR Project Final Report.” (2011). USAID. <http://pdf.usaid.gov/pdf_docs/PA00K6QW.pdf>.

Microlinks. “Tools and Resources: MicroCLIR.” USAID. <https://www.microlinks.org/good-practice-center/value-chain-wiki/climate-legal-and-institutional-reform-tools-clir>.

Fintrac Inc. “AgCLIR Myanmar.” (2014). USAID. <http://eatproject.org/docs/EATAgCLIRMyanmarExecweb.pdf>

Booz Allen Hamilton. “Commercial Legal and Institutional Reform Assessment: Diagnostic Assessment Report for Kosovo.” (2004). USAID. http://pdf.usaid.gov/pdf_docs/pnade547.pdf

AMEX International. “Evaluation of USAID BIZCLIR Program” (2011). <http://pdf.usaid.gov/pdf_docs/Pdact328.pdf>

6.6.2 Most Significant Change (MSC)

A. Summary: Originally developed for evaluation of a complex rural development program in Bangladesh, the Most Significant Change (MSC) evaluation tool has since expanded to include application in both developing and industrialized contexts. MSC involves a participatory process with stakeholders that aims to identify important outcomes, even those previously unidentified or unintentional, through a process of sourcing and selecting stories of significant change from key project stakeholders.

B. Tool Description: This narrative-based tool relies on trained researchers and the participation of stakeholders. First, users select the “domains of change” to be monitored and evaluated. These domains are very broad areas of change (e.g., improved livelihoods) that are later refined. The users then collect stories through in-depth interviews of beneficiaries, clients, and field staff. Next, these stories are analyzed and common themes extracted through levels of hierarchy within the organization or program, such that the top stories are selected and sent up to the next level of authority. A shared document gathers and details the stories chosen by the uppermost

[55] *Ibid*.

hierarchical levels as well as the rationale for those choices. A system enabling the verification of stories can be implemented if needed, by visiting the sites of the described events.

This supports more accurate reporting and allows users to gather additional information on those events that were determined most significant. A more extensive analysis of the summation of the dataset follows, allowing for a synthesis of results as well as an opportunity to revise the process. [56] Ultimately, MSC allows users to verify which components of their intervention had the desired impacts as well as unearth additional, unintended or unreported outcomes / impacts that occurred as a result of the intervention.

C. **Tool Features:** MSC is a "form of dynamic values inquiry whereby designated groups of stakeholders continuously search for significant program outcomes and then deliberate on the value of these outcomes."[57] MSC is an adaptable tool that employs the diversity of stakeholders to identify outcomes that are significant to the participants. The tool uses stakeholder context and values when determining significant consequences, embracing the complexities of outcomes and the non-linear nature of international development programs.[58]

D. **Strengths:** In MSC, outcomes are analyzed from the perspective of participants. This participatory process, an alternative to evaluations based solely on pre-determined indicators, effectively navigates the complexities of diverse cultures and values. This setup can motivate participants and increase stakeholder buy-in. MSC is also known to catch previously unknown, unintended outcomes. [59] As a monitoring approach, this tool is accessible because "there is no need to explain what an indicator is…everyone can tell stories about events they think were important."[60] Additionally, by fueling discussion on which of the stories are most significant, the tool can help organizations make explicit those values they deem most important. Finally, this tool can evaluate more grassroots programming that may lack predefined target outcomes.

E. **Weaknesses:** MSC should ideally be used in conjunction with other evaluation tools and thus cannot be seen as a standalone monitoring and evaluation method. Particularly in situations with a large number of participants, it may not be feasible to use MSC to collect in-depth narratives from all individuals. Users must also have willing participants who are incentivized to share their perspectives, as well as the time to reach out to each of those participants. Thus, there might be human resource constraints for some user groups.[61]

F. **Examples of past use cases:** USAID, through Georgetown University's Institute for Reproductive Health, used MSC as an evaluation tool to determine the outcomes of a health innovation in four countries: Rwanda, Guatemala, India, and Mali. The Institute conducted a six-year study on the

[56] J.J. Dart, R.J. Davies. "A dialogical story-based evaluation tool: The Most Significant Change technique." *American Journal of Evaluation*, 24 (2003), pp. 137–155.
[57] Dart and Davies, 2003.
[58] Willetts, J., & Crawford, P. (2007). The Most Significant Lessons about the Most Significant Change Technique. *Development in Practice*, *17*(3), 367–379.
[59] J.J. Dart, R.J. Davies.
[60] Rick Davies and Jess Dart. "The 'Most Significant Change' (MSC) Technique: A Guide to Its Use." (2005). <http://www.mande.co.uk/docs/MSCGuide.pdf>.
[61] Ibid.

scaling up and integration of various Fertility Awareness Methods (FAM, also known as natural family planning methods) and evaluated the outcomes using MSC. The study found several significant changes as a result of the program. Program managers reported increased knowledge of the menstrual cycle. They also described being better able to respond to client feedback and promote informed consent. Moreover, they were better able to provide for those whose religious beliefs previously prevented them from receiving treatment. The stories collected through MSC improved the program's monitoring and evaluation in focus countries by measuring aspects of scale-up that other instruments could not measure. For instance, MSC confirmed the presence of certain core values (e.g., reproductive rights, women's empowerment, and male involvement) as a result of integrating their Standard Days Method program of preventing pregnancy by identifying fertile days in the menstrual cycle. MSC was lauded as giving participants an outlet where they felt comfortable sharing their views. The organizations participating shared mostly positive experiences with MSC, regarding the tool as a valuable way to preserve the differences in stakeholder core values at all levels of the evaluation process.[62]

G. Resources Required

Pre-conditions/Goals	Time	Human Resources
● Requires users with the skills and time available to devote to collecting participant stories, and field staff and participants who need to consent to recurrent contact ● Stories can be collected more or less frequently ● Consent laws and ethics with regards to minors vary by country[63]	Time intensive; to collect a story: 2 weeks to 1 year (3 months average)	Users, field staff, willing participants

H. Tool Developer & Availability: MSC was developed into an evaluation tool by J.J. Dart and R.J. Davies.

I. References:

J.J. Dart, R.J. Davies. "A dialogical story-based evaluation tool: The Most Significant Change technique." American Journal of Evaluation, 24 (2003), pp. 137–155.

Willetts, J., & Crawford, P. (2007). The Most Significant Lessons about the Most Significant Change Technique. Development in Practice, 17(3), 367–379.

Rick Davies and Jess Dart. "The 'Most Significant Change' (MSC) Technique: A Guide to Its Use." (2005). <http://www.mande.co.uk/docs/MSCGuide.pdf>.

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[62] Institute for Reproductive Health. Georgetown University. (USAID). "Using Most Significant Change Methodology to Evaluate Impact of a Health Innovation in Four Countries." (2013). http://pdf.usaid.gov/pdf_docs/PA00JJMB.pdf. ; Davies and Dart (2005).

[63] Willetts, J., & Crawford, P.

Institute for Reproductive Health. Georgetown University. (USAID). "Using Most Significant Change Methodology to Evaluate Impact of a Health Innovation in Four Countries." (2013). http://pdf.usaid.gov/pdf_docs/PA00JJMB.pdf. ; Davies and Dart (2005).

6.6.3 Outcome Harvesting

A. **Summary:** Outcome Harvesting is a method that enables evaluators, grant makers, and managers to identify, formulate, verify, and make sense of outcomes. An outcome is defined as a change in behavior, relationships, actions, activities, policies, or practices of an individual, group, community, organization, or institution. Using Outcome Harvesting, the evaluator—or "harvester"—gleans information from reports, personal interviews, and other sources to document how a given program or initiative has contributed to outcomes.[64]

B. **Tool Description:** With an emphasis on understanding how activities shape outcomes, Outcome Harvesting lets users determine which outcomes have emerged, working backward to determine whether and how a project or intervention contributed to that change.[65] This tool uses a participatory form of monitoring and evaluation with which it enables users to identify, verify, and make sense of outcomes. The tool helps to clarify the relationship between projects and interventions and the outcomes they influence, with or without reference to predetermined objectives.

C. **Tool Features:** Outcome Harvesting employs systems thinking concepts and can be used for both monitoring ongoing projects and initiatives, as well as for evaluation. As a monitoring tool, Outcome Harvesting can provide real-time information about achievements. For example, Outcome Harvesting is useful for ongoing developmental, midterm formative evaluations[66] (i.e., activities undertaken to furnish information that will guide program improvement, initiated before implementation begins or near the start of a project or program), and end-of-term, summative evaluations. Suitable for complex programming contexts where relations of cause and effect are not fully understood, the tool may be combined with other methods. Conventional monitoring and evaluation aimed at determining results compares planned outcomes with what is actually achieved. In complex environments, however, objectives and the paths to achieve them are largely unpredictable; predefined objectives and theories of change must be modified over time to respond to changes in the context. Outcome Harvesting is especially useful when the aim is to understand how individual outcomes contribute to broader system-wide changes. Advocacy, campaigning, and policy work are ideal candidates for this approach.

D. **Strengths** of Outcome Harvesting are several, including:
   1. Overcomes the common failure to search for unintended outcomes of interventions;
   2. Generates verifiable outcomes;
   3. Uses a common-sense, accessible approach that engages informants quite easily;

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[64] Ricardo Wilson-Grau and Heather Britt, (2012). Outcome Harvesting, May 2012, Ford Foundation.
[65] Learning Lab. "A CLA Dialogue: Missions and partners share experiences and best practices." (2013). USAID. <http://usaidlearninglab.org/e-consultations/e-consultations-resource/outcome-harvesting>.
[66] USAID. "Performance Monitoring and Evaluation Tips: Introduction to Evaluation at USAID. <http://pdf.usaid.gov/pdf_docs/Pnadw111.pdf>.

4. Employs various data collection methods such as interviews and surveys (face-to-face, by telephone, by e-mail), workshops and document review;
5. Answers actionable questions with concrete evidence.

E. **Weakness** or limitations of the tool include:
1. Skill and time, as well as timeliness, are required to identify and formulate high-quality outcome descriptions;
2. Only those outcomes that informants are aware of, are captured;
3. Participation of those who influenced the outcomes is crucial;
4. Starting with the outcomes and working backward represents a new way of thinking about change for some participants.[67]

F. **Examples of a past use cases:** Outcome Harvesting is one of five complexity-aware monitoring approaches promoted by USAID's Complexity-Aware M&E Team.[68] **USAID/Mali's Feed the Future program:** OS Partners Inc., a small, woman-owned, disadvantaged business, is currently implementing the Impact Evaluation and Quantitative Population-Based Surveys for USAID/Mali's Feed-the-Future (FTF), Cereal Value Chain (CVC) Activity. For the CVC impact evaluation, women's role in cereal crop production is documented during a baseline survey, then reviewed periodically during the impact and final evaluations as well as at other times using the innovative Outcome Harvesting approach. The changes observed will suggest ways project interventions could improve to enhance women's roles and increase family nutrition and food security.[69]

G. **Resources Required:**

Pre-conditions/Goals	**Time**
● Requires designing evaluation, engaging actors/users, and reviewing/verifying/classifying outcome statements. ● Identification of social actors as well as the facilitation of interactions with them is required to conduct a thorough and accurate evaluation. [70]	Time-intensive; 1-2 months

H. **Tool Developer & Availability:** Outcome Harvesting was developed by Ricardo Wilson-Grau with colleagues Barbara Klugman, Claudia Fontes, David Wilson-Sánchez, Fe Briones Garcia, Gabriela Sánchez, Goele Scheers, Heather Britt, Jennifer Vincent, Julie Lafreniere, Juliette Majot, Marcie Mersky, Martha Nuñez, Mary Jane Real, Natalia Ortiz, and Wolfgang Richert. Since 2006, Outcome Harvesting has been used to monitor and evaluate the achievements of hundreds of networks,

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[67] Ricardo Wilson-Grau, 2012.
[68] USAID. "Discussion Notes: Complexity-Aware Monitoring." (2013). <http://usaidlearninglab.org/sites/default/files/resource/files/Complexity%20Aware%20Monitoring%202013-12-11%20FINAL.pdf>.
[69] SBAIC. (2014). "Integrating Gender in USAID Monitoring and Evaluation Work. <http://www.sbaic.org/integrating-gender-usaid-monitoring-and-evaluation-work-0.>
[70] Rassmann, Kornelia, et. al. 2013. "Retrospective 'Outcome Harvesting': Generating Robust Insights About a Global Voluntary Environmental Network." Better Evaluation. <http://betterevaluation.org/sites/default/files/Retrospective%20outcome%20harvesting.pdf>.

non-governmental organizations, research centers, think tanks, and community-based organizations around the world. The approach has been widely shared by its developer and other development practitioners and evaluators.

I. References:

Ricardo Wilson-Grau and Heather Britt, (2012). Outcome Harvesting, May 2012, Ford Foundation.

Learning Lab. "A CLA Dialogue: Missions and partners share experiences and best practices." (2013). USAID. <http://usaidlearninglab.org/e-consultations/e-consultations-resource/outcome-harvesting>.

USAID. "Performance Monitoring and Evaluation Tips: Introduction to Evaluation at USAID. <http://pdf.usaid.gov/pdf_docs/Pnadw111.pdf>.

USAID. "Discussion Notes: Complexity-Aware Monitoring." (2013). <http://usaidlearninglab.org/sites/default/files/resource/files/Complexity%20Aware%20Monitoring%202013-12-11%20FINAL.pdf>.

SBAIC. (2014). "Integrating Gender in USAID Monitoring and Evaluation Work. <http://www.sbaic.org/integrating-gender-usaid-monitoring-and-evaluation-work-0.

Rassmann, Kornelia, et. al. 2013. "Retrospective 'Outcome Harvesting': Generating Robust Insights About a Global Voluntary Environmental Network." Better Evaluation. http://betterevaluation.org/sites/default/files/Retrospective%20outcome%20harvesting.pdf

6.6.4 Scenario Planning

A. Summary: A scenario is a story that describes a possible future, helping people explore what the future might look like and the likely challenges or opportunities of living in it. Decision makers can use scenarios to think about the uncertain aspects of the future that most worry them – or to discover the ways in which the future might unfold. Scenarios are intended to form a basis for strategic conversations between people – they are a method for considering potential implications of and possible responses to different events and choices.[71]

B. Tool Description: In 1971, a team of planners within Royal Dutch Shell began using a new forecasting tool called "scenario planning" as part of the company's long-range planning process. The Shell team began using scenarios as an intermediary stage between forecasting and the company's long-range planning process, and the first report proved pivotal to Shell's future abilities to succeed during the 1970s OPEC oil crisis. [72]

Scenario planning involves systems thinking through its recognition of the many factors that combine in complex ways to create surprising futures (due to non-linear feedback loops). The

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[71] Shell International, (2008). "Scenarios: An Explorer's Guide."

[72] T. Carletone, W. Cockayne, and A. Tahvanainen, "Stanford Playbook for Strategic Foresight and Innovation." (2013). Stanford University.

method also allows for the inclusion of factors that are difficult to formalize, such as novel insights about the future, deep shifts in values, unprecedented regulations, or inventions. Systems thinking used in conjunction with scenario planning leads to plausible scenario story lines so long as the causal relationship between factors can be demonstrated. In these cases, when scenario planning is integrated with a systems thinking approach to scenario development, it is sometimes referred to as dynamic scenarios.

C. **Tool Features:** Scenario planning attempts to capture the richness and range of possibilities, stimulating decision makers to consider changes they might otherwise ignore. Scenarios are more than just the output of a complex simulation model. Instead, they attempt to interpret such output by identifying patterns and clusters among the millions of possible outcomes a computer simulation might generate. They often include elements that were not or cannot be formally modeled, such as new regulations, value shifts, or innovations. Hence, scenarios go beyond objective analyses to include subjective interpretations, which can challenge the prevailing mind-set.[73]

D. **Strengths:** Scenario planning is a collaborative, conversation-based process that facilitates the interplay of a wide variety of ideas. This collaborative approach enables different field of knowledge and ways of knowing to be combined. By bringing together different fields of knowledge, scenario planning also allows for the reframing of questions, prompting the generation of ideas across disciplines rather than going over old ground. Unlike forecasting, scenarios do not demand consensus, but rather respect and accommodate differences, provided they are defined clearly. The story form of scenarios enables both qualitative and quantitative aspects to be incorporated, so ideas are not excluded on the basis that they can't be measured. By building sets of scenarios, several different versions of the future are assembles at the same time.

E. **Weaknesses:** Scenario planning initiatives that involve large-scale quantitative models require considerable investment, which can lead to a kind of "model lock-in": difficulty in changing basic assumptions, along with the natural authority of algorithmic calculations, can result in users' being blindsided by changes in the world that don't fit a model's parameters.[74]

F. **Examples of a past use cases:** The **USAID-funded Coral Triangle Support Partnership (CTSP)** program funded a study in 2011 on the use of fish for food security in the Solomon Islands. This study, led by a consortium including the World Wildlife Fund, The National Conservancy, and Conservation International, used scenario planning as the core component of the study, generating possible future scenarios for fish supply and demand in the Solomon Islands during the period 2010 to 2030.[75]

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[73] Paul J. H. Schoemaker. "Scenario Planning: A Tool for Strategic Thinking." (1995). MIT Sloan Management Review. <http://sloanreview.mit.edu/article/scenario-planning-a-tool-for-strategic-thinking/>.
[74] Angela Wilkinson and Roland Kupers. "Living in the Futures." (2013). Harvard Business Review. <https://hbr.org/2013/05/living-in-the-futures>.
[75]Weeratunge, N., D. Pemsl, P. Rodriguez, O.L. Chen, M.C. Badjeck, A.M. Schwarz, C. Paul, J. Prange, I. Kelling (2011). Planning the use of fish for food security in Solomon Islands. Coral Triangle Support Partnership. 51 pp. <http://www.coraltriangleinitiative.org/sites/default/files/resources/1_Planning%20the%20Use%20of%20Fish%20for%20Food%20Security%20in%20Solomon%20Islands.pdf.>

G. Resources Required:

Pre-conditions/Goals	Time	Human Resources	Cost
●A crucial component of some scenario planning efforts is the use of modeling and visualization tools to display and present scenarios to planning participants. ● Resources vary according to chosen approach (qualitative vs. quantitative outputs, diversity of participation, etc.)	Varied	Varied	US$ 50,000-5,000,000[76]

H. Tool Developer & Availability: While there are a number of scenario planning methods, Shell's model is widely referenced. Material can be found on the company's website, which includes their most recent scenarios: http://www.shell.com/energy-and-innovation/the-energy-future/shell-scenarios.html

I. References: Shell International, (2008). "Scenarios: An Explorer's Guide."

T. Carletone, W. Cockayne, and A. Tahvanainen. "Stanford Playbook for Strategic Foresight and Innovation." (2013). Stanford University.

Paul J. H. Schoemaker. "Scenario Planning: A Tool for Strategic Thinking." (1995). MIT Sloan Management Review. <http://sloanreview.mit.edu/article/scenario-planning-a-tool-for-strategic-thinking/>.

Angela Wilkinson and Roland Kupers. "Living in the Futures." (2013). Harvard Business Review. <https://hbr.org/2013/05/living-in-the-futures>.

Weeratunge, N., D. Pemsl, P. Rodriguez, O.L. Chen, M.C. Badjeck, A.M. Schwarz, C. Paul, J. Prange, I. Kelling (2011).

Planning the use of fish for food security in Solomon Islands. Coral Triangle Support Partnership. 51 pp.
http://www.coraltriangleinitiative.org/sites/default/files/resources/1_Planning%20the%20Use%20of%20Fish%20for%20Food%20Security%20in%20Solomon%20Islands.pdf.

Rowland, E.R., Cross, M.S., Hartmann, H. (2014) Considering Multiple Futures: Scenario Planning To Address Uncertainty in Natural Resource Conservation. Washington, DC: US Fish and Wildlife Service.
<http://www.fws.gov/home/feature/2014/pdf/Final%20Scenario%20Planning%20Document.pdf.>

[76] Rowland, E.R., Cross, M.S., Hartmann, H. (2014) Considering Multiple Futures: Scenario Planning To Address Uncertainty in Natural Resource Conservation. Washington, DC: US Fish and Wildlife Service. <http://www.fws.gov/home/feature/2014/pdf/Final%20Scenario%20Planning%20Document.pdf.>

6.6.5 SenseMaker®

A. **Summary:** SenseMaker® is a methodological approach, supported by facilitating software, which has its origins in complex adaptive systems thinking, cognitive science, and anthropology. The approach relies on the collection and analysis, over a set time period, of large numbers of story fragments, or micro-narratives, which capture people's diverse perspectives.[77] These micro-narratives help to uncover foundational attitudes and norms that inform and influence behavior.[78] Once many micro-narratives are collected, the software aids users in identifying patterns and trends that may be significant for action.[79]

B. **Tool Description:** The design of the SenseMaker® tool was based on natural sciences and the humanities and a desire to understand the role of narrative in human decision-making.[80] The process starts with a prompting question or image to trigger the respondent to share an experience or outcome that is significant for the topic being researched. Software aids the users through the analysis of the complexity and diversity of people's lives that are shared in their stories. This helps users identify patterns across the many story fragments that merit further scrutiny. These patterns and the related stories are the basis for 'sense-making' by key project stakeholders.[81]

C. **Tool Features:** The approach is based on the idea that people create identities, share, and give meaning to their lives via narratives. Narratives in this context are micro-narratives, and not extensive stories or life stories or composite interpretations that contain all insights needed. Instead, they are fragments—short stories shared by people that form the basis for subsequent probing with specific questions. These micro-narratives can be captured as text in the form of original experiences, but also as fragments from existing documents, video clips, or photographs.[82] The approach is based on large numbers of such micro-narratives; a form of distributed ethnography, in recognition of the idea that a system consists of a multitude of ever-changing interactions between many 'agents'. Understanding the range of experiences, perspectives, motivations, and values around the topic of inquiry requires sensing this multitude.[83]

   SenseMaker® asks people to give meaning to their own stories by tagging the stories themselves, against pre-defined concepts or topics of interest (the so-called 'signification framework'). By signifying, or giving meaning to their own stories, the basis for statistical analysis that is contextualized in relation to significant experiences is formed—this strongly reduces researcher biases from the initial interpretation. The respondent decides on what their own stories hold meaning, hence the notion of a 'self-signified micro-narrative'. People add layers of meaning to their experience, not just summarizing the story content. In so doing, they open the door to the

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[77] Casella, D., Magara, P., Kumasi, T.C., Guijt, I. and van Soest, A., 2014. *The Triple-S Project Sensemaker® experience: a method tested and rejected*. (Triple-S Working Paper 9) [pdf] The Hague: IRC.

[78] Learning Lab. "Using Systemic M&E Tools in Feed The Future Uganda: Sensemaker." (2015). USAID. <http://usaidlearninglab.org/events/using-systemic-me-tools-feed-future-uganda-sensemaker-%C2%AE>.

[79] Casella 2014.

[80] Senseguide. "What is SenseMaker" (2015). <http://senseguide.nl/what-is-sensemaker/>.

[81] Casella 2014.

[82] *Ibid.*

83 *Ibid.*

world through the eyes of program constituents, intended beneficiaries, or other key stakeholders related to the program of work.[84]

D. Strengths: When continuous and regular story capturing and analysis occurs, users better understand change as it emerges. This enables making real-time adjustments to move a system toward desirable stories; quick feedback and rapid responsiveness becomes possible. In the same process, it can be used to detect weak signals, outliers, and small clusters of stories that may represent hidden and emerging opportunities or obstacles for systems change. SenseMaker® combines qualitative and quantitative data collection and analysis by generating evidence-based “hard” and “soft” data.[85]

E. Weaknesses: SenseMaker® requires sufficient scale in story collection such that alignment with project scope is assured. Further, getting people to share good stories is not easy. But in general, collecting data for SenseMaker® faces similar challenges to traditional survey tools: the training of enumerators, quality of data collected by enumerators, quality control, and access to people.[86] Some analysis of application of the tool reveals that even those who receive considerable training on the approach feel unsure about how to analyze the data or how to use it for sense-making.[87] SenseMaker® is proprietary and expensive in comparison to the many open-source tools covered in this White Paper. Therefore, when using SenseMakker®, it should be clear that the resulting information justifies the investment.[88]

F. Examples of past use cases: Feed the Future in Uganda offers a use case on SenseMaker®. The Feed the Future Agricultural Inputs Activity is a five-year (2012-2017), USD $10 million contract managed by Tetra Tech ARD and funded by USAID. The activity’s aim is to increase farmers’ use of good quality agro-inputs by fostering more inclusive systemic changes in the agro-inputs industry. SenseMaker® was used to gather the perspectives of Ugandan wholesalers who report more than 5 million Ugandan shillings in sales per season (approximately USD $ 1,700). The SenseMaker® interviews were divided into two major parts: relationships with suppliers, and relationships with retailers. First, wholesalers told a story about their most memorable interaction with one of their suppliers in the past six months. Next, the wholesaler answered a series of questions about the story and the relationship, a process called “self-signification,” as the wholesaler was able to give meaning to the story without the interviewer applying their own interpretation. This was then repeated with a story about an interaction with a retailer, providing two sets of stories and their significations. Ultimately, these interviews produced analyses that demonstrated the predominance of simple-trading business models and a need to move toward customer-oriented

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84 Casella 2014.

[85] Deprez, Steff. “Using micro-narratives to organize systematic and real-time feedback on the inclusion of smallholders in modern markets.” (2015). The Bill & Melinda Gates Foundation. <https://vredeseilanden-wieni.netdna-ssl.com/sites/default/files/paragraph/attachments/150122-sensemaker_inclusive_business-veco_steff_deprez.pdf>.

[86] Jenal, Marcus. “Peer-to-peer workshop reveals growing interest in SenseMaker.” (2015). BEAM Exchange. <https://beamexchange.org/community/blogs/2015/10/30/sensemaker1015/>.

[87] *Ibid.*

[88] Carter, L., Dininio, P., 2012. *An Inventory and Review of Countering Violent Extremism and Insurgency Monitoring Systems*, [pdf] Washington DC, MSI

growth strategies such that suppliers proactively engage with wholesalers, who proactively engage with retailers.[89]

G. Resources Required:

Pre-conditions/Goals	Time	Human Resources	Cost
● Collection, manipulation, and analysis of data requires a substantial investment ● Analysis requires sense-making of the data to be performed with stakeholders and respondents[90] ●Requires access to internet and Sensemaker software applications, posing a challenge in some work environments[91]	Time-intensive; 4-6 weeks per iteration	---	Expensive (licensing fee and training of staff)

H. Tool Developer & Availability: The software package was developed by Cognitive Edge and is available by contacting the company.

I. References: Casella, D., Magara, P., Kumasi, T.C., Guijt, I. and van Soest, A., 2014. *The Triple-S Project Sensemaker® experience: a method tested and rejected*. (Triple-S Working Paper 9) [pdf] The Hague: IRC.

Learning Lab. “Using Systemic M&E Tools in Feed The Future Uganda: Sensemaker.” (2015). USAID. <http://usaidlearninglab.org/events/using-systemic-me-tools-feed-future-uganda-sensemaker-%C2%AE>.

Senseguide. “What is SenseMaker” (2015). <http://senseguide.nl/what-is-sensemaker/>.

Deprez, Steff. “Using micro-narratives to organize systematic and real-time feedback on the inclusion of smallholders in modern markets.” (2015). The Bill & Melinda Gates Foundation. <https://vredeseilanden-wieni.netdna-ssl.com/sites/default/files/paragraph/attachments/150122-sensemaker_inclusive_business-veco_steff_deprez.pdf>.

Jenal, Marcus. “Peer-to-peer workshop reveals growing interest in SenseMaker.” (2015). BEAM Exchange. <https://beamexchange.org/community/blogs/2015/10/30/sensemaker1015/>.

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[89] USAID. “USAID FTF Agricultural Inputs Activity: A Modular M&E Scheme” (2014). Seep Learning. <http://www.seeplearning.org/jobtools/monitoring-evaluation/me-scheme/>.

[90] Carter 2012.

91 GirlHub. “Using Sensemaker to understand Girls’ Lives: Lessons Learnt from GirlHub,” (2014). Cognitive Edge. <http://old.cognitive-edge.com/wp-content/uploads/2015/04/GH-SenseMaker-brief.pdf>.

Carter, L., Dininio, P., 2012. *An Inventory and Review of Countering Violent Extremism and Insurgency Monitoring Systems*, [pdf] Washington DC, MSI
USAID. “USAID FTF Agricultural Inputs Activity: A Modular M&E Scheme” (2014). Seep Learning. <http://www.seeplearning.org/jobtools/monitoring-evaluation/me-scheme/>.

GirlHub. “Using Sensemaker to understand Girls’ Lives: Lessons Learnt from GirlHub,” (2014). Cognitive Edge. <http://old.cognitive-edge.com/wp-content/uploads/2015/04/GH-SenseMaker-brief.pdf>.

6.7 Profiles of Tools Not Currently in Use at USAID

6.7.1 Innovation System Analysis

A. **Summary:** The Innovation System Analysis tool enables users to take stock of three key features illustrative of an innovation system: the actors (e.g., firms, government agencies, youth, etc.), interactions (e.g., knowledge flows between universities and firms, etc.), and phenomena (e.g., increasing foreign direct investment in high-technology sectors, etc.) that exist within it. The analysis parses an innovation system into five categories of resources and phenomena, abbreviated with the acronym THICK, which are relevant to innovation: (1) Technologies, (2) Human Resources, (3) Institutional / Infrastructure Resources, (4) Communication / Collaboration Resources, and (5) Knowledge Resources. Upon completion of an Innovation System Analysis guided with this tool, users possess a diagnostic revealing key resources, actors, and phenomena that bear on a system’s capacity for innovation.

B. **Tool Description:** Too often systems analysis can become unbounded and feel overwhelming to program designers and decision makers. Aiming to vastly improve the act of systems analysis and the results derived from it, GKI’s Innovation System Analysis tool guides users through several layers (from micro to macro) of an innovation system and through specific categories of features definitional to an innovation system. Before diving into an Innovation System Analysis, the user must first define the boundary of the chosen innovation system. This boundary may be national, sectoral, or even regional, depending upon which system a user seeks to explore. Defining the boundary of the innovation system – for example, Nigeria, Africa, Silicon Valley, or the agricultural innovation system – allows focus and clarity when determining what actors or phenomena are relevant to the chosen innovation system.

   Next, the user gathers information about the defined innovation system using the THICK framework described above. Working on each of the THICK categories in turn, researchers collect observations and data on the actors, resources, and phenomena that promote or hinder innovation activity, as well as the interactions between these elements. This research can be conducted through any available means: internet-based research, stakeholder interviews, and literature reviews, among others. A table with the five THICK pillars offers one simple method for data organization. Users further identify at which systems level system phenomena and resources occur. The micro level (also referred to as the enterprise level) includes distinct actors that interact directly with each other and are influenced by the macro level. Conversely, the macro level reflects interests, policies, strategies, legal frameworks, as well as the collective physical and knowledge infrastructure that affects actors at the micro level.

C. **Tool Features:** This tried and tested tool helps users understand the innovation system and the factors that promote or hinder innovation activity. What’s more, rather than merely identifying those phenomena that the user deems important for addressing the given problem, this system analysis highlights actors, interactions, and linkages that bear on the problem in important, but less obvious ways.

D. Strengths: This tool allows users to identify the connections between distinct phenomena occurring across the innovation system. What's more, it helps users identify trends and movement within the system to better recognize factors that may either enable or thwart innovation activity—both at present and in the future.

E. Weaknesses: The Innovation System Analysis requires a considerable amount of primary and secondary research to adequately analyze an entire Innovation system. That said, the user decides the size of the system, as determined by the boundary of the innovation system of focus as well as the depth of exploration.

F. Examples of past use cases: In 2012, GKI worked with a team of researchers from the University of Rwanda, led by Dr. Daniel Rukazambuga, then Dean of the Faculty of Agriculture, to rid Rwandan specialty coffee of a taste defect known as "potato taste." This taste defect severely jeopardized one of Rwanda's most profitable industries: coffee. At the outset of building a purpose-driven network to, first, understand the nature of the challenge, then tackle it, the team introduced the novel THICK methodology to guide analysis of two prevailing innovation systems: the national innovation system of Rwanda and the agricultural innovation system. Supported by more than 25 stakeholder interviews, the THICK analysis served as a tool not only for Rwandan stakeholders, but also for foreign partners interested in playing a supportive role in the burgeoning problem-solving network. Focused on identifying opportunities for collaboration with key system stakeholders, the analysis revealed critical innovation system bottlenecks that partnerships would need to address if the coffee challenge were to be solved. Two years later, the network's activities combined the efforts of some 20 institutions globally, straddling four continents, including Rogers Family Coffee, Rwanda's own Agricultural Research Board (RAB) and the Ministry of Agriculture, Starbucks, University California Riverside, Seattle University, CIRAD, and many others. In that same year, the program was dubbed one of the "top 100 social innovations for the next century," a designation credited, in part, to the robustness of the Innovation System Analysis upon which the effort was built.

G. Resources Required:

Pre-conditions/Goals
● To complete the tool, the user needs access to secondary literature and data germane to the innovation system. ● The research team will benefit from direct access to stakeholders in the innovation system to allow for in-person or virtual interviews that correspond to the THICK categories.

H. Tool Developer and Availability: The THICK framework was developed by the Global Knowledge Initiative's Sara Farley, Caroline Wagner, Sukhie Brar, and Bob Hawkins for the World Bank, published in 2011.[92] At the time, the World Bank was seeking a better method to describe and measure systems with regard to whether and how they supported innovation, particularly in developing countries. Uganda and Mozambique were the first two countries in which the World Bank used the THICK framework to analyze innovation. The tool was further elaborated and enhanced by the Global Knowledge Initiative to constitute a simple-to-use tool for innovation systems analysis. The Innovation System Analysis tool is now part of GKI's larger Assessing Innovation Impact Potential toolset, which includes a total of 12 systems and complexity tools. Further, GKI has trained hundreds of practitioners globally on its use.

I. **References**: The World Bank study may be found here: http://www-wds.worldbank.org/external/default/WDSContentServer/WDSP/IB/2011/01/07/000333038_20110107012405/Rendered/PDF/588440PUB0Scie101public10BOX353816B.pdf.
Examples of GKI's application of the Innovation System Analysis tool may be found here: http://globalknowledgeinitiative.org/initiatives/assessing-the-potential-for-innovation.html

6.7.2 Innovation System Enablers and Barriers Scoring Table

A. **Summary:** The Innovation System Enablers and Barriers Scoring Table invites users to methodically explore the degree to which individual enablers and barriers to innovation matter. The tool looks at enablers and barriers from the perspective of key Innovation System stakeholders. This tool asks users to perform this analysis multiple times – each time focusing on specific Innovation System stakeholders associated with single aspects of a problem for which innovation is needed. As a result, the tool aggregates comparisons of enablers and barriers to innovation within a system across multiple dimensions: across problem aspects, across stakeholders, and even across specific innovations. Once completed, decision makers can use the tables to more clearly see the differences in innovation impact potential (measured as the difference between a system's ability to enable or hinder innovation activity in the future as compared to the system's ability to enable or hinder innovation activity in the present) exhibited by different innovations.

B. **Tool Description:** The Innovation System Enablers and Barriers Scoring Table is a novel tool, designed by The Global Knowledge Initiative and the Georgia Tech Research Institute, which guides users through an analysis of enablers and barriers to innovation pertinent to any number of problem aspects. Users generate a list of no fewer than five enablers and five barriers, pulled from the Innovation System Analysis (discussed on pg .64), or looking even further afield. An Excel-based template offered by the tool guides users through an assessment of each enabler and barrier in turn, facilitating assessment of the degree to which it affects individual stakeholders. The table asks users to assign values for each innovative activity and the degree to which the enabler or barrier affects those system stakeholders that undertake that innovative activity. Scoring uses a simple Likert scale. A unique value of the Assessing Innovation Impact Potential toolset is its preoccupation with how systems change over time. The tool offers space for users to consider how specific enablers or barriers are likely to change between the present and the future. To do this, each enabler and barrier is scored a second time by considering its effect on each stakeholder at a set point in the future (e.g., in five years). While a large amount of data is needed

[92] Brar, S. Farley, S., Hawkins, R. and Wagner C. (2011). "Science, Technology and Innovation in Uganda: Recommendations for Policy and Action." World Bank.

to complete the tool, once finished, it tells an instructive story to decision makers. Specifically, the tool requires first completing the Influence and Incentives Matrix, which determines those system stakeholders with the highest scores in terms of influence and incentive to innovate, described in more depth elsewhere in this white paper (see pg. 86).

By way of example, consider the challenge of post harvest food loss in Sub-Saharan Africa. This overarching problem consists of a number of more discreet issues, or "problem aspects," such as (1) short shelf-life leading to food spoilage during storage and (2) the lack of farmer organizations, among many others. If examining the Sub-Saharan African Innovation System, for example, in which weak distribution channels for technology and intellectual property rights act as two possible enablers or barriers, the tool would enable comparison of the Sub-Saharan African Innovation System's degree of innovation activity as affected by these enablers and barriers. Additionally, the Enablers and Barriers Scoring Table not only shows users the relative strength of each of these enablers or barriers, but it also allows comparison of which problem aspect—shelf-life vs. farmer organizations—is most hospitable to innovation.

C. **Tool Features:** So often, innovation systems are looked at generally for their amenability to innovate, rather than the relative strengths and weaknesses between different types of innovation activity as undertaken by an array of different innovation system stakeholders. That an innovation system may be more attuned to research than to distribution of existing innovations is a story uncovered through thoughtful use of this tool. Moreover, integrating scores that indicate possible future changes helps decision-makers grapple with the complex nature of innovation systems and the degree to which they enable and thwart innovative activity not in a static way, but in a dynamic one. Ultimately, determining the impact that a set of innovations may potentially deliver is an insight available only after unpacking the strength of innovation system enablers and barriers on these innovations.

D. **Strengths:** This tool offers users a compelling integration of narrative, indicator, and visual comparisons of changing enablers and barriers to innovation on given problem aspects over time. Using auto-populated spider (or radar) charts, the tool clearly presents information such that it is primed for decision makers. Because this tool measures the relative weight of factors enabling or hindering innovation activity not only in the present, but also in the future, it is set apart from static tools in its ability to contend with the dynamic nature of systems.

E. **Weaknesses:** In order to accurately rank the relative weight of the selected enablers and barriers, users must obtain a considerable amount of data, which can be time consuming, depending upon human resources availability. Moreover, it is difficult for some users to grasp the idea of scoring enablers and barriers in the future. Doing so requires the ability to draw both insights and directional changes from data sets, but does not involve predicting the future.

F. **Examples of past use cases:** In 2015, The Rockefeller Foundation enlisted GKI and a team of content researchers to explore the potential of innovation to address economic exclusion in cities in high-income countries. The research team's analysis revealed that poor job quality was one of the most significant problem aspects affecting economically excluded groups. Using GKI's Innovation System Enablers and Barriers Scoring Table, the research team assessed the extent to which specific enablers and barriers currently support or thwart innovative activity carried out by stakeholders including national governments, labor unions, large firms, and small- and medium-sized enterprises. The team identified regional partnerships and clusters, as well as active peer learning among key stakeholders, as enablers conducive to innovation. Critical barriers for innovation included ongoing political gridlock and significant inter-city competition for jobs. The results revealed a future trend of lessening barriers and strengthening enablers to innovation, suggesting that a focus on addressing job quality for economically excluded populations may be an area of interest for foundations and other actors interested in addressing this challenge.

G. Resources Required:

Pre-conditions/Goals	Time
● Requires users to draw on information generated in the Innovation System Stakeholder Analysis ● Scoring table does not require any special software	Once data is gathered, completing scoring table takes 1 week

H. Tool Developer and Availability: This tool was developed by the Global Knowledge Initiative in consultation with systems of systems engineering experts at the Georgia Tech Research Institute (GTRI) as part of the larger Assessing Innovation Impact Potential toolset, supported by a grant from The Rockefeller Foundation.

I. References: http://globalknowledgeinitiative.org/initiatives/assessing-the-potential-for-innovation.html

6.8 Identified Gaps

No single category of systems and complexity tool—narrative, visualization, indicator-based--singularly satisfies the needs of practitioners at every stage in the USAID program cycle, let alone within the innumerable specific use cases that particular problems (e.g., food security versus energy insufficiency), contexts, and systems present. Gaps exposed by narrative-tools are, therefore, in some instances, similar to those expressed in other tool categories. It is exciting to consider the opportunities ahead for systems and complexity researchers, practitioners, and decision makers seeking to close the gaps between the field of systems and complexity research and the ways in which the resulting tools, methods, and mindset can be sculpted and shaped to meet specific needs. Four of these gaps follow:

1. Current scholarship and codification of best practices around the translation of narrative-based tools into visual- or indicator-based approaches is limited. Though narratives can certainly support more quantitative approaches by pairing them with other tools, the method for doing so is often unclear. However, the SPACES consortium is offering a solution to this challenge in that we are not only conducting a landscape analysis of these three categories of systems and complexity tools, but we are also focused on examining and testing their integration.

2. Systems and complexity scholars do not yet fully understand the impacts on decision-making of narrative-based tools as compared to indicator-based tools or to visual tools. Until we can better understand the ability for these tools to transform international development decision-making, questions surrounding optimal use and implementation will go unanswered. To best answer these questions, the field is in need of rigorous testing, including perhaps random control trials, that compare decision-making with the assistance of systems and complexity tools to decision making in their absence. While we are not able to complete these trials, one of key objectives of the

SPACES consortium is to pilot and test changes in decision-making at USAID as a function of using these tools. Thus, our consortium is committed to both monitoring and learning from the behavioral changes triggered through adoption of these tools, in hopes we will contribute to filling this gap.

3. One of the key challenges for implementing narrative-based tools, and systems and complexity tools generally, is finding the equilibrium between time and knowledge limitations and the incentive to use these tools. There is a point at which making tools too "user friendly" by making them simpler and less time- and resource-intensive means they can no longer grapple with the true complexity of systems. Thus, we need to find ways to make systems and complexity tools readily available to the international development practitioners who need them, while also maintaining a certain level of rigor required to increase understanding, optimize monitoring and evaluation, and improve decision-making at USAID and across the social sector and beyond.

4. There is a gap in systems thinking around the nature and comparative value of tools as opposed to frameworks as opposed to mindsets. For instance, if an organization focuses on instilling their employees with a systems mindset and the ability to make key programmatic decisions from a systems perspective, might not a large number of tools and approaches then become "systems tools and approaches" to those individuals? Likewise, if there is a cognitive disconnect with regard to systems, even tools such as the Innovation System Analysis cannot effectively speak to the systems dynamics. Given this mindset gap, the international development field might require a combined approach that marries a robust training in systems thinking with a more simplified set of tools to support that changed mindset.

6.9 Recommendations

Observing the above discussed strengths, weaknesses, and gaps with regard to narrative-based systems and complexity tools, it is clear that the SPACES consortium has a unique opportunity to capitalize on those strengths and navigate around those roadblocks in a novel and integrated manner. Given that no single category of systems and complexity tools—narrative, visualization, indicator-based—singularly satisfies the needs of practitioners at every stage in the USAID program cycle, the following recommendations serve to guide practitioners and decision makers through the exciting process of building a foundational systems mindset supported by a suite of fit-for-purpose, adaptable tools to grapple with complexity at any and every program stage. The three recommendations are as follows:

1. Before beginning a journey with narrative-based systems and complexity tools, users should consider their appetite for using these tools to build systems awareness within their community of practice, Mission, Bureau, designated group of stakeholders, etc. Quite excitingly, many of these tools are participatory (e.g. Innovation System Analysis, Most Significant Change, SenseMaker®, etc.). Therefore, users should explore the benefits of making systems analysis an experiential activity rather than an academic/theoretical one, given that many narrative-based tools lend themselves to participatory monitoring and evaluation and, broadly speaking, participatory development.

2. Given the participatory nature of many narrative-based tools, users should exert caution and sensitivity engaging with stakeholders. Drawing out stories and narratives from stakeholders can be time intensive and can also elicit sensitive information; hence, users of these tools must always weigh the costs and benefits before asking participants to engage.

3. Users should not be dissuaded by the notion of complexity and the degree to which grappling with uncertainty is at the heart of these tools and approaches. Rather, users should embrace the fact that narrative-based tools do not remove uncertainty; they help users contend with it. So, while the notion of systems and complexity can sound overwhelming and intimidating, narrative-based tools are not. Users should test them out knowing that the mandate of narrative-based systems and complexity tools is to clarify ambiguity and wrestle with some of the thorniest questions that lie at the heart of international development.

7. INDICATOR-BASED APPROACHES

7.1 Definition

An indicator is a specific and objectively verifiable measure of change or results brought about by an activity or a set of activities. Indicators are variables that help to measure changes in a given situation in a given period of time. They are tools for monitoring the effects of an activity and are designed to provide a standard against which to measure or assess or show the progress of an activity against stated targets. Setting targets depends on many factors including resources that will facilitate attainment of the desired objective. Much as a set target guides the implementer, a low target can be a source of complacency while a high target may bring about unnecessary stress and demotivation. It is therefore upon the researcher or designer to set realistic targets that will be attained in line with the desired objectives. Indicators can be direct or indirect, shorthand or proxy. Effective Indicators should be determined by the nature of the objectives, intended effects and impact of the Project and must be i) valid, ii) reliable, iii) relevant, iv) sensitive, v) specific, vi) cost effective, and vii) timely.

Traditional M&E systems predominantly employ static indicators. These types of indicators are set ex-ante and are used to set fixed targets about the desired change at different stages of a project. They tend to remain static over the course of the project, unless reviewed during process evaluation. Static indicators are often selected to follow program logic. The most commonly used of the static indicator systems is the Logical Framework Approach (LFA) and its variants. In the LFA, indicators are layered in a hierarchical logic, from: Inputs to Processes, Outputs, Outcomes and Impacts or selections of these. The presumption is that activities and indicators at one level in the hierarchy will contribute to attainment of the next level, if certain assumptions hold true, and forward on until the desired impacts are realized in whole or in part. The assumptions that ought to be met for the expected deliverables to be realized are also determined at the beginning of the project and included in the log-frame. Some projects then prepare risk mitigation plans targeting these assumptions. The LFA is not the only approach to static indicators. The US Global Development Lab for example which is mainly involved in catalyzing Science and Technology innovations to solve global development challenges uses an 'innovation pipeline' approach to monitor outputs and outcomes from its innovations ecosystem. Indicators are selected in a hierarchy of 5 key dimensions that culminate in hierarchical outcomes: Design, Pilot, Early Adoption, Transition to Scale, and Wide-scale adoption. Within each of these outcome stages are some milestones based on standard practice in innovation pipelines and tagged to outputs.

However, modern MERL has opened up to the realization that static indicators are far from sufficient to enable understanding of complex systems. Projects (whether innovation projects or social interventions) often operate in complex systems. There are many system level variables that interact with the project, moreover in a dynamic and changing way. These variables may substantially affect its course and the extent of attainment of key targets. The effect of these variables on attainment of desired results might be as important as the project activities themselves. And these variables are not captured by traditional static indicator systems. While LFAs attempt to cater to external factors by including ex-ante assumptions and mitigating factors, environmental factors that affect project implementation, diffusion of interventions and attainment of outcomes cannot be fully predicted ex-ante. This reality therefore necessitated the development of dynamic indicator based M&E tools. The LFA can be extended to include systemic features that divert the linearity of the logframe by allowing feedback loops which enable iterative adjustments to the assumptions and mitigation factors to reach the desired goal.

7.2 Subcategorization of Indicator-based Approaches

To understand complex systems using indicator-based approaches two categorizations have been applied: the top-down and the bottom-up approaches[93]. In the top-down approach a complex system is broken down into smaller components or subsystems to which measurable variables or indicators are attached for monitoring specific aspects of the subsystems that highlight a whole system. On the other hand the bottom-up approach considers the relevant indicators and these are grouped to fit into the different subsystems that are representative to bring about comprehension of the whole complex system.

In defining criteria and indicators for sustainable forest management Khadka and Vacik (2012)[94] describe the top-down approach as expert-driven while the bottom-up approach is community-driven. In the top-down approach, experts adapt a predetermined set of indicators to a local situation. In the bottom-up approach, the community actively participates in formulating indicators bringing their perception of the situation into perspective.

In assessing sustainability of agricultural systems Binder and Feola (2012)[95] elaborate further on the above approaches into three classifications: top-down, farm assessment; top-down, regional assessment with some stakeholder participation; and bottom-up, integrated participatory or transdisciplinary approach. In the top-down, farm assessment the farmer himself or industry working with farmers groups have the mandate to derive the indicators and determine how they will be measured without participation of other stakeholders. The top-down, regional assessment allows involvement of a limited number of stakeholders in the indicator development and targets multiple stakeholders who are likely to use the results. The bottom-up integrated or transdisciplinary approach focuses on engaging stakeholders throughout the process, from goal setting to indicator formulation, measurement and use of the results.

In the case where all subsystems of a complex system can be identified, the top-down approach would be ideal to give a full understanding of the complex system. However, in reality identification of all the

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[93] Yu, D. and Yin, J. (2011) Internet GIS and System Dynamic Modeling in Urban Public Safety and Security Studies: A conceptual Framework, in Luo, Xiangfeng; Cao, Yiwei; Yang, Bo; Liu, Jianxun and Ye, Feiyue (eds), *New horizons in web-based learning - ICWL 2010 workshops : ICWL 2010 workshops: STEG, CICW, WGLBWS, and IWAKDEWL, Shanghai, China, December 7-11, 2010 : revised selected papers*, pp. 207-216, Springer, Berlin, Germany

[94] Khadka, C., and Vacik, H, (2012). Comparing a top-down and bottom-up approach in the identification of criteria and indicators for sustainable community forest management in Nepal. An international journal of forestry research, 85 (**1**): 145-158

[95] Binder, C.H., and Feola, G. (2012). Normative, systemic and procedural aspects: a review of indicator-based sustainability assessments in agriculture. Methods and Procedures for Building Sustainable Farming Systems, 33-46

subsystems may not be achievable rendering the bottom-up approach more tenable in such situations[93]. Khadka and Vacik (2012)[94] advocate application of both approaches in order to enhance mutual learning and sharing experiences. While top-down formulated indicators may lack acceptability and ownership on the part of the stakeholders, the bottom-up approach can be applied as a complement since by allowing stakeholder involvement it increases the likeliness of the results being applied and the stakeholders ownership in the monitoring and evaluation process.

7.3 Uses and Types of Questions That Can Be Addressed

Different sectors use different questions through different types of indicators that are of interest to the sector. However, in most cases the common goal for asking the questions points to quality improvement purposes. Some of the questions that can be addressed using indicator-based approaches include, but are not limited to the following:

- What is happening in my system in a given context? What matters most?
- What is the implementing partner doing and how well are they doing it?
- Why specific implementing partners achieve particular outcomes?
- What is the progress of interventions towards desired results according to predetermined implementation plans?
- How do capacity development efforts influence the lives of beneficiary communities? The answers to this question are used as a measure of the changes in organizational performance that are the outcome of strengthened policies, procedures and skills.
- How are students progressing in learning to reach a desired benchmark for success? These questions are often used by teachers to identify those students that will most likely require more intensive instruction early enough in the school year in order to pave a way on how best to help the students catch up.
- What behavioral patterns influence development impacts?
- How best can we share the progress towards achieving desired results with multiple audiences including managers, donors, partners, members, and the general public?

7.4 Overall Strengths

Indicator-based complex systems tools have the following strengths:

- They cater to the changing nature of the implementation environment. With the complex systems tools the outcome is not limited to a pre-determined measure but through continuous collection and analysis of information flexibility is allowed that the implementer is free to adopt to the system environment.
- They foster a deeper understanding of the interaction between the intervention and the environment, helping to clarify better the link between activities and their outcomes in the system
- They help to identify external factors affecting project implementation so that corrective action can be taken early enough.
- They provide signals for deeper changes in the system, enabling implementers to dig deeper for these effects. Quantitative measures are usually used to capture the surface features in the system. However, for in-depth insight an application of qualitative indicators can capture other essential elements in the complex system that cannot be addressed quantitatively.

7.5 Overall Weaknesses

Although indicator based systems tools have made it possible to monitor and evaluate projects in dynamic, complex and changing implementation contexts, there are some characteristics of complex systems that are still not captured by existing tools. In particular, the following gaps in existing indicator based tools are observed:

1. There is a scarcity of tools that connect dynamic indicators to static indicators within the complex systems in which projects are implemented. Currently a lot of emphasis is based on reporting of outputs when monitoring and evaluating programs compared to outcomes and impact. This is not surprising to bigger extent since the outputs are easily captured numerically and the available tools can handle such information. On the contrary, capturing systemic features requires more explanations that are not incorporated with existing tools.
2. There is a shortage of tools that facilitate capture of 'emergent' indicators. Existing tools tend to emphasize ex-ante search for indicators that change over time (e.g. dynamic indicators, sentinel indicators). We need tools that facilitate forward-going capture of emerging non-predetermined indicators that affect attainment of static milestones
3. There is also a need for tools that go beyond current 'calendaring based approaches' used in project management soft-ware to capture 'time to attainment of milestones' in a way that enables the tracking of 'rates of progress' of projects, and using their trajectories to enhance project performance

7.6 Profiles of Tools Currently Being Used by USAID

7.6.1 Process Monitoring of Impacts (PMI)

A. **Summary:** Process monitoring of impacts is an approach that tracks the progress of the activities and implementation mechanisms/behaviors of partners or target groups. It utilizes inputs and outputs to produce results and impacts. The approach combines the likeliness of impacts at early stages of the implementation phase and the main actors or implementing partners responsible for achieving the desired results or impacts. PMI elaborates on the basic four-component logic model to include the notion of "use": use of inputs to produce outputs; use of outputs to produce results and impacts; direct use of outputs to yield short-term outcomes (results) and indirect use of outputs to produce medium to long-term outcomes (impacts). PMI can be applied at both project level and measure level[96] [97] [98].

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[96] Hummelbrunner. R, (2006) Process of Monitoring of Impacts: Proposal for a new approach to monitor the implementation of 'Territorial Cooperation' programmes. Available at https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=2&ved=0ahUKEwiXtLnaou3KAhVLCBoKHUyhCyIQFggzMAE&url=http%3A%2F%2Fwww.economy.gov.sk%2Fext_dok-interact_study_process_monitoring_of_impacts-4803%2F116226c&usg=AFQjCNG9uLU0SE7XwbqZE-w5qosIp6UHUQ

[97] Hummelbrunner. R, Huber. W, & Arbter, R, (2005) Process Monitoring of Impacts: Towards a new approach to monitor the implementation of Structural Fund Programmes. Available at https://www.bka.gv.at/DocView.axd?CobId=14624

[98] Discussion Note (2013) complex-aware monitoring, Monitoring and evaluation series, version 2. Available at: https://usaidlearninglab.org/sites/default/files/resource/files/Complexity%20Aware%20Monitoring%202013-12-11%20FINAL.pdf

B. **Tool Description:** Process Monitoring of Impacts takes the form of a logical diagram depicting: outputs, use of outputs to achieve results, results, use of outputs to achieve impacts, and indicators attached to results and impacts. Particularly, the approach involves four steps: identifying the intended results and impacts and selecting the priority areas; specifying why and how the inputs and outputs will lead to the selected results and impacts. These assumptions are based on activities and main actors involved in the project implementation to realize the results and impacts; attaching indicators, qualitative and/or quantitative, to selected results and impacts in order to monitor whether the processes are taking place in the implementation; defining data collection plans, analysis and interpretation while clearly specifying the actors that will be responsible for the various tasks. Data are gathered to capture intended and unintended results and impacts while noting deviations from the set intentions to provide source of information for gap identification, learning and improvement in the project implementation.

C. **Tool Features**: The tool tracks processes which include project activities and behavior of the main actors involved in the implementation process. The degree to which the actors use the inputs and outputs determines the progress to achievement of the project objectives.

D. **Strengths:** Captures the impact-producing processes before changes would be realized in the corresponding performance indicator. It expects emerging new processes to which project implementation can be adapted. Describing processes in relation to their context helps to identify alternative causes, multiple causal pathways, and feedback loops. And, it is suitable for tasks whose qualitative features are difficult to measure quantitatively.

E. **Weaknesses:** It is focused on intended results and may not capture unintended results and it requires extensive awareness on the part of the user to capture all results.

F. **Examples of past use cases:** A pilot application for the INTERREG IIIB CADSES project TECPARKNET (Network of Technology Parks)[97]. TECPARKNET comprises regions in Austria, Italy, Slovenia, Croatia and Hungary aimed at achieving improved competitiveness and a better economic situation for the regions involved Sample PMI Logic model.[99] Literature has limited feedback from field trials of complexity-aware monitoring approaches, of which PMI is a part. However, insights can be traced with USAID’s Office of Learning, Evaluation, and Research (LER) in the Bureau for Policy, Planning, and Learning (PPL)[100].

G. **Resources required:**

Time
Time-intensive

H. **Tool Developer and Availability:**

[99] Williams, B. and Hummelbrunner, R. (2011). *Systems Concepts in Action: a Practitioner’s Toolkit*. Stanford: Stanford University Press.
[100] http://usaidlearninglab.org/lab-notes/deep-dive-complexity-aware-monitoring-usaid

The approach has originally been developed in Canada by the International Development Research Centre (IDRC) and is used in German Development Aid by Bundesministerium für Zusammenarbeit (BMZ) and Gesellschaft für Technische Zusammenarbeit (GTZ).

I. References:

Hummelbrunner. R, (2006) Process of Monitoring of Impacts: Proposal for a new approach to monitor the implementation of 'Territorial Cooperation' programmes. Available at https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=2&ved=0ahUKEwiXtLnaou3KAhVLCBoKHUyhCyIQFggzMAE&url=http%3A%2F%2Fwww.economy.gov.sk%2Fext_dok-interact_study_process_monitoring_of_impacts-4803%2F116226c&usg=AFQjCNG9uLU0SE7XwbqZE-w5qosIp6UHUQ

Hummelbrunner. R, Huber. W, & Arbter, R, (2005) Process Monitoring of Impacts: Towards a new approach to monitor the implementation of Structural Fund Programmes. Available at https://www.bka.gv.at/DocView.axd?CobId=14624

Discussion Note (2013) complex-aware monitoring, Monitoring and evaluation series, version 2. Available at: https://usaidlearninglab.org/sites/default/files/resource/files/Complexity%20Aware%20Monitoring%202013-12-11%20FINAL.pdf

Williams, B. and Hummelbrunner, R. (2011). *Systems Concepts in Action: a Practitioner's Toolkit*. Stanford: Stanford University Press.

7.6.2 Sentinel Indicators

A. Summary: A Sentinel Indicator (SI) is a type of proxy indicator that identifies individual events or phenomena that are intrinsically undesirable, each incident signaling the need for further analysis and investigation. It is used as a bellwether for indicating that greater changes are occurring within a complex system and can be easily communicate[98] [101].

B. Tool Description: According to Williams and Hummelbrunner (2011)[99], SIs are developed by constructing a holistic picture of the project and the system that includes results, as well as causal factors and pathways not represented in the logic model's single causal pathway, for example by mapping out the multiple causal pathways and feedback loops that link the project with actors and factors in the broader context. The system map should include a diverse array of actors and influencing factors, with special attention paid to alternative perspectives and descriptions of how things work. At the strategic level, a system map might start with the narrative description of the development hypothesis underlying a development objective. The level of detail used for this will likely be greater than that included in the results framework. At the project level, the problem analysis may include similar information. Special attention should be paid to assumptions

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[101] Glossary of environmental science. (n.d.) In Wikepedia Glossary of Environmental Science. Available at https://en.wikipedia.org/wiki/Glossary_of_environmental_science

underlying the theory of change because these capture the interactions between a project or strategy and the system in which it is embedded. SIs are placed at critical points (leverage points) in a system map to help monitor and inform the mutually influencing relationship between the program and its context. According to Meadows (1999, p. 1)[102], "leverage points are "places within a complex system (a corporation, an economy, a living body, an ecosystem) where a small shift in one thing can produce big changes in everything." Like "game-changers," sentinel indicators may not require targets and their effect on the system is not predetermined1[103].

C. Tool Features: Sentinel indicators signal changes in the relationships among actors and factors in a situation. Second, sentinel indicators can be chosen to represent key perspectives separate from those of USAID. Third, sentinel indicators can be useful when placed outside the boundaries defining a project or strategy.

D. Strengths

- Sentinel Indicators give a understanding of context which helps to experiment, iterate, learn and adapt
- Sentinel Indicators complement, rather than replace, performance monitoring systems
- Sentinel indicators complement a LogFrame or results framework

E. Weaknesses

As a proxy, however, this type of indicator cannot be used as a stand-alone tool but is used in addition to other tools such as standard performance indicators.

F. Examples of past use cases: This tool was used with USAID Feed the Future project in Uganda. An Agricultural Inputs activity was designed to foster positive systemic changes in the agricultural inputs industry. This is the wholesalers of the inputs needed for agriculture, fertilizer, equipment, seeds. The firm implementing this project, Tetratech, foresaw that for their project to be successful, it would need to focus on the business relationships among the actors in this agricultural market system. They wanted to help the key actors move out of a zero sum mindset and become more growth oriented. They also realized that to be able to do this effectively, they would need some type of process for understanding the patterns of all the factors that go into a relationship, patterns of connections and referrals, trust, satisfaction and investment. And how could they package that in a quantifiable, manageable process? In this case they designed a SI focused on asking their participants who they have purchased products from, and who have you resold products to? And from this one core indicator, they were able to gain significant insight into the system of relationships among these key actors, and the real beauty of it was they could aggregate the data and see in total the percentage of the relationships every year, growth in partnerships, decrease in partnerships, but they could if they wanted, dig into the data and dice it

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[102] Meadows, D. (1999). Leverage points: Place to intervene in a System. Hartland, VT, USA, The Sustainability Institute.

[103] "Game-changers" is a CLA term used to refer to an event likely to have a significant effect of unknown nature on development results. The effect of a game-changer is unknown because it represents a complex aspect of the situation.

up to fit their needs to look at specific geographic sectors or dealers in certain types of inputs. This data was then fed into quarterly strategic assessments.

G. Resources required:

Time	Human Resources
Time for analysis	Systems thinking staff, analytical staff

H. Tool Developer and Availability: Developed by USAID staff in consultation with outside experts

I. References:

Glossary of environmental science. (n.d.) In Wikepedia Glossary of Environmental Science. Available at https://en.wikipedia.org/wiki/Glossary_of_environmental_science

Meadows, D. (1999). Leverage points: Place to intervene in a System. Hartland, VT, USA, The Sustainability Institut

7.6.3 Outcome Mapping (OM) Approaches

A. Summary: Outcome mapping is a methodology that uses a systemic and participatory approach for planning, monitoring and evaluation of development initiatives in order to bring about sustainable social change[104]. It is used both 'ex-ante' and during implementation to track the outcomes of interventions at different stages. It is mostly concerned with behavioral outcomes and outcomes are viewed as 'contributing to impact' rather than directly leading to it.

B. Tool Description: Outcome mapping measures behavioral change exhibited by secondary beneficiaries. It does not focus on measuring deliverables and effects on primary beneficiaries hence differing from traditional metrics or project evaluation. The key difference between outcome mapping and most other project evaluation systems is its approach to the problem that a project's direct influence over a community only lasts for as long as the project is running. It becomes difficult to attribute resultant change in those communities directly to the actions of the project itself. The outcome mapping approach therefore focuses less on the direct deliverables of the project and focuses more on the behavioral changes in peripheral parties affected by the project team. Thus, an outcome mapped project report will focus less on the project's actual progress and more on the project's influence (both deliberate and unintended) during the project's progression[104]. The outcome mapping process consists of two phases, namely a design phase and a record-keeping phase. During the design phase, project leaders identify metrics in terms of which records will be kept. During the record keeping phase, three types of records can be kept, and it is largely up to the project leaders or donor organization to decide which of the three (or all three) types of records should be reported back on. The records related to the items of the design phase

[104] Earl, S., F. Carden, and T. Smutylo, (2001) *Outcome mapping.* Building learning and reflection into development programs. Ottawa: International Development Research Center.

and they include: (1) Performance Journal, which is essentially a collection of minutes of the meetings at which the project's progress with regard to the organizational practices; (2) Strategy Journal, which is a record of actions taken in terms of the strategy map (or tactics grid) along with results of such actions; and (3) Outcome Journal, which is an anecdotal record of any events that related directly or indirectly to the progress markers[105]

C. **Tool Features:** Outcome Mapping is based on three main concepts: 1) Theory of change which recognizes that change is complex, continuous non-linear, cumulative-beyond the control of the program and two way: the program is both 'agent of change' as well as 'subject to change' 2) Sphere of influence, it focuses on those individuals, groups and organizations with whom a program interacts directly and with whom the program anticipates opportunities for influence. 3) Outcomes as behavioral change outcome mapping focuses on one particular type of result: outcomes as behavioral change. Outcomes are defined as changes in the behavior, relationships, activities or actions of the people, groups and organizations with whom a program works directly[106].

D. **Strengths*:*** Outcome mapping is a robust methodology that can be adapted to a wide range of contexts. It enhances team and program understanding of change processes, improves the efficiency of achieving results and promotes realistic and accountable reporting. It provides a set of tools that can be used stand-alone or in combination with other planning, monitoring and evaluation systems[107].

E. **Weaknesses** Potential users of OM should be aware that this approach often requires a "mind shift" of personal and organizational paradigms or theories of social change. It is more concerned about contribution than attribution. It is said not to replace traditional metrics but merely complement it. It has also been said that it simply side-steps the attribution issue and its procedures are too long and complex.

F. **Examples of past use cases**: In 2008, an outcome-mapping project in collaboration with the Central Local Health Integration Networks (LHINs) in Ontario was designed. The outcome-mapping exercise was initiated for the purposes of creating stakeholder alignment around a shared vision and producing a comprehensive, clear, and actionable roadmap to guide decisions and actions[108]. Key concepts of outcome mapping, particularly Outcome Challenges and Progress Markers were applied in the development of a common gender-indicator framework for CARE's pathways program that was supported by USAID Technical and Operational Performance Support (TOPS) program, a USAID/Food for Peace-funded learning initiative[109].

G. **Resources required:**

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[105] Tucker, W.D. and E.H. Blake, (2008). *The role of outcome mapping in developing a rural telemedicine system*.
[106] Wilson-Grau, R. (2013). *Evaluating the effects of international advocacy networks*. in *Advocacy Impact Evaluation Workshop, Evans School for Public Affairs, University of Washington*.
[107] Smith, R., J. Mauremootoo, and K. Rassmann, (2012). *Ten years of Outcome Mapping adaptations & support.* IDRC, Ottawa(http://www. outcomemapping. ca/resource/resource. php.
[108] Tsasis, P., et al., (2013). *Outcome mapping for health system integration.* J Multidiscip Healthc. 6: p. 99-107.
[109] http://www.carepathwaystoempowerment.org/wp-content/uploads/2015/04/Gender-indicator-design.pdf

Pre-conditions/Goals
● Outcome mapping requires skilled facilitation as well as dedicated budget and time, which could mean support from higher levels within an organization.

H. Tool Developer and Availability: The outcome mapping approach was designed by the evaluation unit of International Development Research Centre (IDRC) in 2001. It was based on the outcome engineering model developed by Barry Kibel of the Pacific Institute for Research and Evaluation. Much of the terminology and procedures that occur in outcome engineering are also present in outcome mapping.

I. References:

Earl, S., F. Carden, and T. Smutylo, (2001) *Outcome mapping.* Building learning and reflection into development programs. Ottawa: International Development Research Center.

Tucker, W.D. and E.H. Blake, (2008). *The role of outcome mapping in developing a rural telemedicine system*.

Wilson-Grau, R. (2013). *Evaluating the effects of international advocacy networks*. in *Advocacy Impact Evaluation Workshop, Evans School for Public Affairs, University of Washington*.

Smith, R., J. Mauremootoo, and K. Rassmann, (2012). *Ten years of Outcome Mapping adaptations & support.* IDRC, Ottawa⟨ http://www. outcomemapping. ca/resource/resource. php.

Tsasis, P., et al., (2013). *Outcome mapping for health system integration.* J Multidiscip Healthc. 6: p. 99-107.

7.6.4 MIRADI Adaptive Management software

A. Summary: Miradi is a Swahili word meaning "project" or "goal". Miradi Adaptive Management software for Conservation Projects is conservation software that helps project managers and teams to design, plan, implement, and monitor conservation projects. The software uses examples, wizards and several views through a step by step process as elaborated in the tools features below[110].

B. Tool Description: Miradi is a conservation management software that provides user tools that help track project activities, budgets, action items, and who is responsible for which activities. The software takes the user through essential features to design, manage, monitor, and learn from their conservation projects. The practice of good adaptive management using Miradi involves use of either pen and paper, or programming together functions from a wide range of other programs such as; flowcharting, mapping, project planning, spreadsheet, accounting, and other software

[110] Miradi: Adaptive Management Software for Conservation Projects. Available at https://miradi.org/

packages. Miradi Adaptive Management software takes the right functions from each of these different kinds of programs and bundles them together in one easy-to-use integrated package.

C. Tool Features: Miradi has seven key features that include; Step by Step Interview, Diagram View, Threat Rating View, Viability Analysis, Strategic Planning and Monitoring Views and Work Plan and Budget Views. The step by step interview feature is a conceptual diagram that provides a visual overview of a project's situation in a flowchart format. Within this feature, Miradi presents users with a series of friendly wizards that guide them through a structured process which is the creation of project management, monitoring, and implementation plans according to the *Open Standards for the Practice of Conservation*. This approach allows users to jump back and forth between steps as needed. The diagram view provides a visual overview of a project's situation in a flowchart that shows the strategies of the project, beliefs of how the project activities will lead to desired outcomes and specifies the result chain anticipated after intervention implementation and finally highlight the indicators of measurement. The threat rating view guides practitioners through the process of rating direct threats to determine which ones are the most important to address. The viability analysis view asks users to look at each of their conservation targets carefully to determine how to measure their project over time**.** Strategic planning and monitoring views allow users to develop their project's specific goals and objectives using the guidance from the interview process and finally the work plan and budget views converts strategic and monitoring plans into a series of tasks attached to different project team members who use Miradi's activity calendar to monitor progress and track results and develop financial budgets. Miradi gives the user options for reporting the data entered using a library of report templates.

D. Strengths: The Miradi Adaptive Management software program is relatively easy to use and does not require a high level of specialist expertise. It provides a convenient next step for working a plan through implementation with associated resources and tasks. Miradi uses a flexible design process that can be adapted to other settings.

E. Weaknesses

- The software does not currently allow developing maps of projects
- Though Miradi will enable a library of images, documents, datasets or other files, it will not store the information itself, but will enable project teams to catalog and manage it.

F. Example of past use cases: Measuring Impact, a five-year initiative of the USAID/E3/Forestry and Biodiversity Office (FAB). The MIRADI tool was used to learn how conservation projects contribute to reducing pressures and achieving the conservation of biodiversity focal interests[111].

Caribbean challenge which aimed at getting 20 Million acres in Marine Protected Areas by 2020. A demo to upload the measures data can be viewed at the Miradi measures dashboard[112].

G. Resources required:

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[111] Lauck. L., *et al.* (2014). Measuring Impact: A learning approach to strengthening USAID Biodiversity Programs. Available at https://usaidlearninglab.org/sites/default/files/resource/files/kmrg_061114_ppt.pdf
[112] Salzer, D. (2013). Miradi Measures Dashboard Demo. Available at https://www.youtube.com/watch?v=i2nrZDvVBxE

Cost
Miradi annual subscription costs: US$ 300 for individual, US$ 250-285 for organization

H. Tool Developer and Availability: Miradi is a joint venture between the Conservation Measures Partnership and Sitka. Benetech built the initial software and led its development and innovation from 2007 to 2013. In 2013, Sitka took over development

I. References:

Miradi: Adaptive Management Software for Conservation Projects. Available at https://miradi.org/

Lauck. L., *et al.* (2014). Measuring Impact: A learning approach to strengthening USAID Biodiversity Programs. Available at https://usaidlearninglab.org/sites/default/files/resource/files/kmrg_061114_ppt.pdf

Salzer, D. (2013). Miradi Measures Dashboard Demo. Available at https://www.youtube.com/watch?v=i2nrZDvVBxE

7.6.5 Dynamic Indicators

A. Summary: According to Dalal-Clayton and Sadler (2014)[113], dynamic indicators are indicators that show change over time and in a scenario-based system these show up as the most critical. Dynamic indicators are used to understand the non-linearity of systems over time. From the literature search, the use of dynamic indicators has had limited applications in the different sectors. However, in the education system, extensive work has been done on research-based measures to regularly monitor the development of early literacy and early reading skills, a study popularly known as **Dynamic Indicators of Basic Early Literacy Skills (DIBELS)**. To this end, presentation on dynamic indicators is based on the series of studies on DIBELS.

B. Tool Description: Construction of dynamic indicators is context specific where key features must be defined to determine the scope of measurement over time. To construct a dynamic indicator, the first step is to conduct an assessment of the current situation in the study area focusing particularly on the natural resources and human factors. This is followed by identification of changes/dynamics within the complex system. Furthermore, it is important to identify the stakeholder needs[114].

C. Tool Features: The technique of dynamic indicators includes a clear specification of the long-term goal that will be reached. These indicators include specifying a cut-off score against which one

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[113] Dalal-Clayton, B., & Sadler, B. (2014). *Sustainability appraisal: A sourcebook and reference guide to international experience*. London [u.a.]: Routledge.

[114] Elliot, J., Lee, S., & Tollefson, N. (2001). A reliability and validity study of the Dynamic Indicators of Basic Early Literacy Skills-Modified. School Psychology Review, 30(1), 33-49

would gauge the progress towards goal achievement. This tool allows for prediction of student performance in order to estimate the occurrence of school dropouts and how best to manage it. In other words, DIBELs possesses the following features: benchmark screening, progress monitoring, online scoring and interventions.

D. Strengths: They are effective and efficient. Dynamic indicators focus on key features that feed into the broader perspective and they help track progress over time and assist create a determinant for better performance overtime

E. Weaknesses: Cannot be used as a stand-alone tool but is used in addition to other tools. Although it is possible to project into the future, the predictive power of the tool is limited by the empirical data at hand.

F. Examples of past use cases: Dynamic Indicators were first used *at* the University of Oregon in the late *1980s* in the DIBELS *(Dynamic Indicators* of Basic Early Literacy Skills) research that investigated a set of procedures and measures for assessing the acquisition of early literacy skills from kindergarten through sixth grade[115]. DIBELS has been used together with the Data System in over 15,000 schools across the US and internationally. The DIBELS Data System is a web-based database that schools and districts can use to enter student performance results and create reports based on scores from DIBELS 6th edition. School personnel can utilize the DIBELS Data System reports to make instructional decisions about children's reading performance. DIBELS was used in the Education Data for Decision Making (EdData II) USAID project contracted with Research Triangle Institute (RTI) International to develop an instrument for assessing early grade reading[116].

G. Resources required:

Time	Human Resources
Data requirements: (1) Universal screening at 3-11 minutes per student (2) Data entry at 3 minutes per class, and (3) Printing at 30 seconds per report	Skilled staff to develop and use dynamic indicators

H. Tool Developer and Availability: Developed by © Dynamic Measurement Group and can be downloaded.

I. References:

[115] Kaminski, R. A., and Cummings, K. D. (2008). Linking Assessment to Instruction: Using Dynamic Indicators of Basic Early Literacy Skills in an Outcomes-Driven Model. Available at https://dibels.org/papers/PM_BDA_032708.pdf
[116] http://download.ei-ie.org/Docs/WebDepot/EGRA%20note%2015%20July%202015.pdf

Dalal-Clayton, B., & Sadler, B. (2014). *Sustainability appraisal: A sourcebook and reference guide to international experience*. London [u.a.]: Routledge.

Elliot, J., Lee, S., & Tollefson, N. (2001). A reliability and validity study of the Dynamic Indicators of Basic Early Literacy Skills-Modified. School Psychology Review, 30(1), 33-49

Kaminski, R. A., and Cummings, K. D. (2008). Linking Assessment to Instruction: Using Dynamic Indicators of Basic Early Literacy Skills in an Outcomes-Driven Model. Available at https://dibels.org/papers/PM_BDA_032708.pdf

7.6.6 Organizational Performance Index

A. Summary: Organizational performance index (OPI) is a measure of performance of organizations. While capacity development has been carried out in many organizations, the question that remains unanswered is how effectively did the capacity development outputs contribute to better performance of an organization, its staff and systems. To answer this question, the OPI has been used to measure performance of organizations taking into account various factors. Such factors differ with the OPI measure being applied. The OPI used by the organization PACT is an indicator that measures change brought about by the use of outputs of capacity development efforts to improve performance of organizations, networks and systems[117]. The Kenya institute of management (KIM) OPI[118] assesses organizations according to indicators specific to their particular sector to establish the relative competitiveness of different geographies and sectors.

B. Tool description: The unit of measurement for OPI includes organizations such as community-based organizations, faith-based organizations, civil society organizations, foundations, associations and many more. The pact OPI is constructed based on four domains of organizational performance namely Effectiveness, Efficiency, Relevance and Sustainability. Under each domain two sub areas are taken into consideration. In the effectiveness domain, achieving results and meeting standards are the key areas. Efficiency focuses on enhancing delivery and increasing reach. The relevance domain emphasizes engaging target populations and embracing learning. Lastly, sustainability considers mobilizing resources and harnessing social capital. In each sub-area, organizational performance is measured on a scale of 4 levels, 1 being the lowest and 4 the highest performance. The organization is rated 1 to 4 in correspondence to the 4 levels as agreed between pact and the organization. The two sub-area scores are averaged to get the domains score, and in turn the domains scores are averaged to get the organizational score. The implementation process to calculate the pact OPI involves four steps: partner preparation for the upcoming OPI scoring, planning for data collection, data collection, entering data into database, and finally data analysis. The KIM OPI rates organizations on a scale of 1 to 10 using seven Global Determinants: Leadership and Management; HR Focus; Customer Orientation and Marketing; Financial Management;

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117 Pact, (2015). Organizational Performance Index (Opi) Handbook: A Practical Guide To The Opi Tool For Practitioners And Development Professionals. Available at http://hkdepo.am/up/docs/OPIhandbook_pact.pdf

118 KIM, (2014). *Organisational Performance Index*. *Kenya Institute of Management Available at http://opi-africa.co.ke/about-opi*.

Innovation and Technology; CSR and Environmental Focus; and, Productivity and Quality. These determinants are geared to ensure that all stakeholders' needs are met. The organizations are then assessed based on sector-specific indicators. The rating of the organizations in the sectors of Agriculture; Education and Training; Financial Services; General Consumer Services; Government; and Utilities; Healthcare; Hospitality; Manufacturing; Pharmaceuticals; Food Processing and Telecommunications enables them to benchmark performance and competitiveness against other players in the industry.

C. **Tool Features:** The tool focuses on output level changes in internal organizational systems, structures, policies and procedures. It allows visualization of cross-organizational trends and to disaggregate by impact area, location, organizational type and sector. It also allows reporting high level results to ensure accountability of the work the organization undertakes.

D. **Strengths:**

- It measures organizational change at the outcome level with a focus on external performance
- Allows close monitoring of cross-organizational trends and to disaggregate by impact area, location and organizational type
- Allows an individual or organization to make evidence-based decisions about funding, new business opportunities, staff excellence and areas for improvement
- The tool provides data to support organizational understanding of theory of change and of the impact we are making in the world
- Research organizations will also be able to use organizations' OPI rating to establish the relative competitiveness of different geographies and sectors.

E. **Weaknesses:**

- OPI does not measure attribution
- OPI data is not appropriate in making country-to-country comparisons
- OPI does not examine organizational systems, policies, practices and procedures, and is therefore not a good basis for the development of an Institutional Strengthening Plan
- OPI also does not assess risks involved in potential engagements with local partners, nor do the results of OPI help in determining the type partner
- To support funding or support decisions it is mandatory to use it in combination with other assessments and records of partner performance

F. **Examples of past use cases:** Pact OPI was developed in 2011 by Pact and used in the Pact Project in Ethiopia, Vietnam, South Sudan, Swaziland, Nigeria, Zimbabwe. Pact OPI was also piloted in 2015 in Malawi USAID mission to see how OPI could complement existing tools such as Organisational Capacity Assessment (OCA) or PODA (Counterpart tool for institutional capacity) and to generate lessons around best practices for its use[119].

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[119] https://usaidlearninglab.org/sites/default/files/resource/files/experience_with_opi_malawi.pdf

G. Resources required:

Pre-conditions/Goals
● OPI trained staff and budget that incorporates data collection and data analysis to avoid any additional costs

H. Tool Developer and Availability: KIM OPI was developed by Kenya Institute of Management 2011. Pact OPI was developed in 2011 and is freely available for public use through a Creative Commons license provided credit is given[120].

I. References:

Pact, (2015). Organizational Performance Index (Opi) Handbook: A Practical Guide to the OPI Tool for Practitioners and Development Professionals. Available at http://hkdepo.am/up/docs/OPIhandbook_pact.pdf

KIM, (2014). Organisational Performance Index. Kenya Institute of Management Available at http://opi-africa.co.ke/about-opi.

7.7 Profiles of Tools Not Currently Being Used by USAID

7.7.1 The Dynamic Project Trajectory Tracking Toolkit

A. Summary: The Dynamic Project Trajectory Tracking Toolkit is a project management, monitoring and evaluation tool that actively links predetermined project milestone indicators with three types of dynamic, emergent system-based indicators: 1) dynamic implementation targets, 2) actual dates of attainment of the milestones relative to planned dates, and 3) emergent but compact qualitative explanatory variables for variance. All these indicators are tracked in time as the project transits through the implementation pipeline. Because the milestone indicators have an implied temporal relationship to each other, and because the events are captured dynamically over time, it is possible to construct project trajectories that not only show the 'rate of progress' of the project vis-a-vis the set dates, but demonstrate variance from planned dates, alterations of trajectory courses and explanations for variance. For several semi-synchronous projects in an ecosystem, project funders are able to monitor in real-time the project cohort, detecting projects that are moving much faster or much slower than the others, but more importantly capturing explanatory information for deviance. It is also possible to construct indices for 'early implementation impact potential', so that impact evaluation can be brought forward into early project implementation.

B. Tool Description: This tool is suited to development programs that run multiple intervention projects that follow a similar shared pipeline structure. The pipeline does not need to be strictly similar, but critical parts of the program cycle should be similar across the projects in the ecosystem. It can apply to projects following different project cycles. For example, it can apply to projects following the LFA approach (inputs, process, outputs, outcomes, impacts). It can also apply to innovation projects following a shared pipeline direction (e.g. the design, pilot, early

[120] https://usaidlearninglab.org/library/organizational-performance-index-measurement-tool

adoption, transition to scale, wide-scale adoption format that USAID's GDL follows). At the inception of the system, we set static shared indicators related to attainment of key shared milestones anticipated across projects. For each milestone, the awarding organization agrees together with the project teams the anticipated start date for implementation of the milestone's activities as well as the anticipated date they commit to attain the milestone results. This information is captured as a baseline reference point on which all subsequent 'dynamic' events relational to these dates are tracked in the system. These preliminary specifications are the only static part of this monitoring system but they are important because dynamic indicators will be referenced to them. All subsequent downstream indicators are dynamic, and are described as follows:

- For each project in the ecosystem, the project owners set project specific targets that breakdown the milestones. These targets vary from project to project. They can be changed by the project teams independently of the awarding organization's approval.
- For each milestone, project teams submit a report on the day the milestone is attained. This allows tracking of time-to-attainment of milestones and the tracking of several milestones allows plotting of trajectories to show 'rate of progress'.
- If milestone due-dates are not met or delayed, the system notifies the respective project managers and requests for 'short qualitative explanations' of what is happening. This enables real-time capture of system level context-specific variables affecting attainment of outcomes. When the due dates are substantially over-due, the system issues a project stall warning that should prompt more rigorous follow-up action.
- All dates set can be revised based on learning from actual experiences in implementation (resetting). Project teams can ask for more time (reset), as long as 'short qualitative explanations' are provided and the awarding organization consents. The system also allows project teams to make iterations on their milestone outputs and filing a new report. Iteration is a vital part of innovation ecosystems.
- Because the milestones have a temporal hierarchy, it is possible to plot project trajectories that track the rate of progress of individual projects towards attainment of transformative impacts. Project trajectories can also be compared with each other, since the tracker imputes and plots time-to-attainment of milestones other than actual calendaring. Therefore, projects that are moving semi-synchronously in different time plans can be tracked on the same platform.
- The graphic below shows the back-end features that are supported by this system:

Static indicators		Bridging indicators			Dynamic indicators			Trajectory
		A	B	C	D	(C-B)/ (B-A)	Emergent Indicators	(C-B)
		Date Planned start *(Reset option)*	Date Due *(Reset option)*	Date milestone Attained *(Reset option)*	Dynamic targets attained	Variance *(Imputed and signalled)*	Short explanation for variance (Text, 250 character)	Time to milestone (Headline tracker)
Outcome 1	Output 1.1							
	Output 1.2							
	Output 1.3							
Ou	Output 2.1							

	Output 2.2							
	Output 2.3							

C. Tool Features: The tool consists of the following:

- An interface for setting shared project stages, milestones, and milestone indicators (the static aspect of the tool)
- An interface for enrolling projects into the ecosystem, setting key milestone due dates, and a mechanism for resetting of dates to accommodate repeating the milestone, extension of milestone due dates, or capturing iteration of milestone deliverables
- An interface for project managers to set their own intra-milestone targets and revise them
- A mechanism for submission of milestone reports and their clearance following quality assurance checks by awarding organization, computation of time to attainment of milestones, imputation of delays, stalling and fast-tracked milestone performance
- A mechanism for capturing short qualitative explanations for milestone delays, resets, repetition or iteration through short (250 character) explanations to facilitate interaction with the system
- A mechanism for plotting multiple project performance trajectories and imputation of impact potential

Summary of key features:

- Allows real-time monitoring of project trajectories to detect slow and fast progress in relation to static indicators attached to time-to-attainment of milestones
- Allows capture of explanatory variables for trajectory critical points; these provide a dynamic link between static indicators and the environment
- Based on these two aspects, managers can understand what needs to be tweaked in the system (action points) to overcome project drag
- Project managers can model impact potential during early implementation
- Project managers can compare trajectories of multiple projects in a cohort to visualize the performance of their entire portfolio

D. Strengths:

- Allows static indicators to interact with system level indicators in real-time, providing dynamic context specific explanations for performance
- It links time to actual milestones, enabling computation of rates of progress and tracking of projects trajectories.
- By detecting major milestone delays and learning from external explanatory factors that affect implementation, project managers are able to undertake corrective or supportive actions to increase potential for project success
- The unit of monitoring is the actual project. Reporting is therefore bottom up, allowing the funding agency to capture monitoring data in real-time
- Impact potential metrics can be used to detect major project drag so that we are able to detect failure early to avoid wastage of resources
- It is web-based, hence ubiquitous; it can be adapted to mobile phones

E. Weaknesses: It is highly dependent on project managers' active participation in updating the system with milestone information. It requires frequent interaction between project implementers and supervisors from the funding agency to set and reset milestone dates.

Deliverables and explanations of variance require to be quality checked and approved by monitoring officers of the awarding organizations for proper quality control. With many projects in the ecosystem, the multiple awarding organization supervisors are needed otherwise they may be overwhelmed

F. **Examples of past use cases:** RAN is a USAID funded project under the Higher Education Solutions Network (HESN), whose purpose is to source innovations that build resilience of communities. Currently, we are incubating a portfolio of 20 different projects that were awarded incubation grants, and we are anticipating to award at least 20 more. All of these projects are moving along a standard innovation pipeline in relation to shared milestones and time. However, because the projects are transiting at different speeds through the pipe, it is not possible to set single due dates for each project. Although these projects share a similar pipeline they were enrolled into the pipeline at different times and they move asynchronously. In addition, even projects that started out on the same dates with similar due dates ended up performing differently due to a number of external factors. Because of the dynamic way in which these projects interact with their implementation contexts, manual tracking and reporting of projects had been cumbersome. There was need for a tool that could ease tracking of the projects relative to each other as well as the context based factors affecting attainment of milestones. The proposed tool provides a platform with which all projects in RAN's ecosystem can be tracked simultaneously. Based on their trajectories and qualitative explanatory variables for deviance, it can allow identification of key pipeline stages where there is drag so that critical decisions are taken early in project implementation to address drag. Impact potential simulation can also help with decisions on whether to take a project forward or not.

G. **Resources required:**

Pre-conditions/Goals	Time	Human Resources

• Installation of the tool on a web-based platform for project monitoring; the tool is currently under development and a refined prototype will be ready within 1-2 months. - Installation of the application for an organization interested would require: • Needs finding: An inception workshop with the organization's M&E and implementation team to elucidate: their project/subproject set up and administration and the core program outcome and output indicators as well as their initial time commitments. These would be as the basis for customization of the DTPP platform for the target under organization. This step would be in two parts: Prior exchange of program information to facilitate a desk review, following which RAN facilitates a brain-storming workshop with the program team • Customization of the tool: Based on the situational analysis information, the project team would work with the program team to customize the tool to the target organization and enroll the subprojects • Training: The RAN team would then conduct a training of project/sub-project M&E staff on how to operationalize the system	•1.5+ months for application installation (needs finding: 2 weeks • Customization: 1 month • Training (1-3 days)	Project supervisor, at least one M&E personnel for sub-projects. Technical support: RAN team would provide user support to facilitate normalization and integration of the system

H. **Tool Developer and Availability:**
The tool is under development by ResilientAfrica Network
It will be available by license. However, for agencies that would like to pilot the tool, no subscriptions for the tool will be required, the pilot budget will suffice.

7.7.2 Systems Influence and Incentives Matrix

A. **Summary:** The Influence and Incentives Matrix is a simple tool that helps to identify, categorize, and prioritize key stakeholders within an innovation system according to their respective influence over the innovation system, and their incentives to undertake innovation-based activity (including research, regulation, financing, distribution, etc.) aimed at addressing a particular problem. The Systems Influence and Incentives Matrix can help a user:

1. Recognize key system stakeholders with the influence necessary to either support or undermine innovative activity aimed at solving a given problem, depending upon their incentives to do so.
2. Understand which stakeholders wield the greatest power to facilitate or execute innovation-related activities applied to a specific aspect of a problem.

Working first through a series of ranking tables, the tool ultimately provides users with a set of easy-to-digest System Influence and Incentives Matrices that help decision makers visualize and compare various stakeholders' relative influence on an innovation system and incentive to innovate[121].

B. Tool Description: This tool begins with the user listing the main problem aspects that offer discrete opportunities for innovation. For example, problem aspects for post-harvest food loss might include both short product shelf-life (which causes food spoilage during storage) and lack of farmer organizations, among others. The next step entails creating a list of actors engaged in innovation activity, doing so by considering those actors relevant to each specific problem aspect in turn. For example, the problem aspect "lack of farmer organizations" might include such relevant innovation system stakeholders as smallholder farmers, extension agents, and the Ministry of Agriculture, to name a few. Users repeat this step, making a list of key innovation system actors for each problem aspect. Guiding the designation of key innovation stakeholders, the tool invites users to consider seven types of "innovation activity" an innovation system actor might perform. These include: (1) generation/research, (2) adaptation, (3) diffusion, (4) funding, (5) regulation, (6) management, and (7) usage. For each innovation system actor, users use the tool to rate the degree of influence that the actor has on each of the seven innovation activities. Repeating the scoring process for each actor across each innovation activity determines those actors with the highest influence on innovation activity aimed at each problem aspect.

Next the tool aids users in calculating stakeholders' "incentive to innovate" scores. Users consider the following prompt for each actor: what incentive does this actor have to undertake a given innovation activity with the goal of addressing the given problem? Once all influence and incentive scores for all actors are calculated, using the Excel-based tool, they are easily plotted on a set of auto-populated matrices, one matrix per problem aspect. With influence represented on the y-axis and incentive represented on the x-axis, the top 5 innovation system stakeholders become clearly visible.

C. Tool Features: The enthusiasm for an innovation that promises to solve a challenge too often wanes as an innovation fails to make the journey from blueprint to pilot to scale. Since no single actor controls the destiny of an innovation in terms of its likelihood to succeed at scale, it is critical to uncover the array of innovation systems stakeholder who matter at each stage of the journey and for each kind of innovation activity. Doing so allows users to uncover not only who has influence on specific innovation activities (research versus distribution versus regulation, etc.) but who has the incentive to actually undertake those specific innovation activities aimed at a particular problem of focus. Specifically, this tool enables users to recognize key risks and opportunities to innovation by gauging the degree to which distinct innovation system stakeholders can fuel or hinder innovation.

D. Strengths: The Systems Influence and Incentive Matrix converts system-based information that can be difficult to unpack into a set of indicators and accompanying visualizations that are quite easy to comprehend as well as to complete. The tool provides richness in its ability to analyze and

[121] http://globalknowledgeinitiative.org/initiatives/assessing-the-potential-for-innovation.html.

compare key innovation system stakeholders based on their ability and their willingness to address a given problem. By producing simple 2x2 matrices on which system stakeholders are plotted, decision-makers can then determine key partnership strategies and can identify early on in the program cycle potential bottlenecks to action. Finally, when coupled with Social Network Analysis, this tool offers an unparalleled exploration into the nature, connection between, and meaning inherent in system stakeholders incentives and influence.

E. **Weaknesses:** Before using this tool, the user must take the time to conduct a full analysis of the chosen innovation system, highlighting the key innovation system actors. Through desk research and, ideally, stakeholder interviews, this process can be time consuming. Equipped with that analysis, however, this tool is both rapid and user-friendly.

F. **Examples of past use case:** Recognizing the complex, multidimensional nature of urban inequality, The Rockefeller Foundation called on the Global Knowledge Initiative to work with researchers from the Urban Institute to assess the potential for innovation impact on the challenge of economic exclusion in cities. The innovation system of focus was the OECD innovation system. After completing the Innovation System Analysis guided by this toolset, the team developed a list of stakeholders instrumental to the innovation system. The diverse list of actors included stakeholders from national and local governments, financial institutions, public service providers, tech entrepreneurs, and more. After assigning each stakeholder an influence and incentive score, performed by scoring their influence on innovation activities and their incentive to undertake such activity, the team assembled four Influence and Incentive Matrices. These matrices revealed national governments, research institutions, and multinational corporations to be the stakeholders with the greatest influence on innovative activity addressing economic exclusion in cities, while the urban labor force and local governments possessed the greatest incentive to see that innovative activity occur.

G. **Resources required:**

Pre-conditions/Goals	**Time**	**Human Resources**
● This tool requires background research on the innovation system in question (which is supported by another tool overviewed in the “Narrative Tools” section of this paper, namely the “Innovation System Analysis Tool”), and specifically on the actors within that system.	Data compilation up to 1 month, tool completion in 1 day	Individual or team effort

H. **Tool Developer and Availability:** This tool was developed by the Global Knowledge Initiative in consultation with systems of systems engineering experts at the Georgia Tech Research Institute as part of the larger Assessing Innovation Impact Potential toolset, supported by a grant from The Rockefeller Foundation.

I. References:

http://globalknowledgeinitiative.org/initiatives/assessing-the-potential-for-innovation.html.

7.8 Identified Gaps

Although indicator based systems tools have made it possible to monitor and evaluate projects in dynamic, complex and changing implementation contexts, there are some characteristics of complex systems that are still not captured by existing tools. In particular, the following gaps in existing indicator based tools are observed:

1. There is a scarcity of tools that connect dynamic indicators to static indicators within the complex systems in which projects are implemented
2. There is a shortage of tools that facilitate capture of 'emergent' indicators. Existing tools tend to emphasize ex-ante search for indicators that change over time (e.g. dynamic indicators, sentinel indicators).
3. There is a shortage of tools that capture qualitative explanatory variables that tell us more about the behavior of the system, alongside the widely used program indicators. In addition to the Dynamic Project Trajectory Tracking Toolkit, the narrative-based tools can be used to bridge the gap of in-depth understanding of the system
4. There is also a scarcity of tools that track project portfolio progress using time as a variable. As such, current indicator based tools to not sufficiently support the simultaneous tracking of projects that share a similar result and outcome structure.

7.9 Recommendations

There is need for indicator based systems tools that connect dynamic indicators to static indicators within the complex systems in which projects are implemented.

Such tools should facilitate capture of 'emergent' indicators. We need tools that that facilitate forward-going capture of emerging non-predetermined indicators that affect attainment of static milestones. These tools should capture qualitative explanatory variables that tell us more about the behavior of the system, alongside the widely used program indicators. Such qualitative variables can then be linked to key results, so as to explain how dynamic and emergent system level variables affect the progress of projects.

There is also a need for tools that go beyond current 'calendaring based approaches' used in project management soft-ware to capture 'time to attainment of milestones' in a way that enables the tracking of 'rates of progress' of projects, and using their trajectories to enhance project performance. This will not only make it possible to compare the progress of projects that share similar results and outcome structure, but will enable easy identification of results stages responsible for the most drag in implementation. The Dynamic Project Trajectory Tracking Toolkit discussed in this paper serves to provide insight into the project progress. Identification of drag will enable a drill down to understand the system level explanatory variables (captured as qualitative descriptions) to enable timely intervention to alter project trajectories and increase the impact potential of projects.

8. TOOL INTEGRATION AND ADDED VALUE OF SPACES MERL

The categories of tools presented in this White Paper are organized around those techniques that each grouping of tools most prominently employs. Mapping approaches within Visualization Methods identify prominent system features and relationships among them, modeling approaches incorporate dynamics, demonstrating how system features might change given different circumstances, policies and interventions. Narrative tools bring constituent experience and perspectives to the fore and highlight system areas poised for successful interventions. Indicator-based tools do well to capture specific change within a program or intervention, directly attributable to such interventions and accounting for emergence within the broader system as a whole. These techniques are ripe for integration, building off one-another depending upon the extent to which such information is readily available, and the overall objectives of the research. Therefore, the user should not focus on choosing a single tool. Rather, users are advised to focus on identifying tools that are poised to work together to answer users' systems and complexity questions and/or to support decision-making at all stages of the program cycle.

While there are many different opportunities for integration among systems tools, we will describe one potential way for the tools to fit together to enhance the work of a particular project.

To start, **Narrative Approaches, such as GKI's Innovation System Analysis** can produce a system-wide diagnostic to infuse **Mapping Approaches, such as LINC's Social Network Analysis**. The Innovation System Analysis, and other narrative-based approaches such as the Systems Influence and Incentives Matrix can provide a qualitative analysis of the system, enabling the SNA researcher to better understand key actors and interactions within the system, triangulating this information with observations on stakeholder incentive structures and the broader network structure. By combining specific narrative methods with social network analysis, the user can gain a "snapshot in time" of the phenomena, actors and interactions that compose the chosen system. However, some narrative based tools, such as the Enablers and Barriers Scoring table, look beyond the present to identify where best to intervene for maximum impact. **Modeling approaches, such as the GOPC's HERMES platform**, can build from these approaches to anticipate emergence within a system. By applying computational modeling methods to robust SNA datasets (enhanced by narrative techniques such as Innovation System Analysis, Influence and Incentives Matrix, Enabler and Barriers scoring table etc.) the user can identify a particular set of intervention and policy options, modeling their potential impact on the system or network. Furthermore, the user can test the validity of results by conducting an ex post facto SNA assessment of actual versus projected network change. Once the user has begun project implementation, they can employ **Indicator-Based approaches, such as RAN's Dynamic Project Trajectory Tracking Toolkit**, to detect which emergent system-level factors affect the attainment of anticipated results for a project portfolio, thus allowing for adaptive management and a higher success rate across project activities. This is simply one description of how complex system tools of different categories can complement each other; however, there are many additional formulations and opportunities for the tools to work together and build off one another.

The SPACES MERL consortium aims to provide a suite of tools that cover each of the complex system tool categories and offers packages of synergistic tools, tailored to specific program needs. Combined, SPACES MERL tools provide deeper insights into the behavior of the systems in which a program operates which enables smarter design and more impactful projects at all levels of the program cycle.

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U.S. Agency for International Development
1300 Pennsylvania Avenue, NW
Washington, DC 20523
Tel: (202) 712-0000
Fax: (202) 216-3524
www.usaid.gov