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# Conceptualizing a New Knowledge Management Logic Model for Global Health: A Case-Study Approach

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**Abstract.** Over the past few decades, knowledge management (KM) has become well-established in many fields, particularly in business. Several KM models have been at the forefront of promoting KM in businesses and organizations. However, the applicability of these traditional KM models to the global health field is limited by their focus on KM processes and activities with few linkages to intended outcomes. This article presents the new Knowledge Management for Global Health (KM4GH) Logic Model, a practical tool that helps global health professionals plan ways in which resources and specific KM activities can work together to achieve desired health program outcomes. We test the validity of this model through three case studies of global and field-level health initiatives: an SMS-based mobile phone network among community health workers (CHWs) and their supervisors in Malawi, a global electronic Toolkits platform that provides health professionals access to health information resources, and a netbook-based eHealth pilot among CHWs and their clients in Bangladesh. The case studies demonstrate the flexibility of the KM4GH Logic Model in designing various KM activities while defining a common set of metrics to measure their outcomes, providing global health organizations with a tool to select the most appropriate KM activities to meet specific knowledge needs of an audience. The three levels of outcomes depicted in the model, which are grounded in behavioral theory, show the progression in the behavior change process, or in this case, the knowledge use process, from raising awareness of and using the new knowledge to contributing to better health systems and behaviors of the public, and ultimately to improving the health status of communities and individuals. The KM4GH Logic Model makes a unique contribution to the global health field by helping health professionals plan KM activities with the end goal in mind.

**Keywords:** knowledge management, logic model, global health, KM framework, health professionals, health outcomes

## 1. Introduction: Brief History of Knowledge Management in Global Health and Development

Knowledge management (KM) has been widely popular in many fields—for example, business and library and information science—for the past several decades. However, KM was virtually absent in the global public health and development community until multilateral and bilateral donor institutions such as the World Bank, the U.S. Agency for International Development (USAID), and the World Health Organization (WHO) began applying it to their work in the mid- to late-1990s (World Bank, 1999; Rodrigues, 2000). Since then, KM has been adopted by numerous global health organizations and professionals and has been increasingly recognized for its contribution to stronger health systems, which can in turn improve health outcomes for families and communities (Liebowitz, Schieber, and Andreadis, 2010; World Health Organization, 2006).

A number of studies have firmly established the importance of providing health professionals with access to the latest technical information (Jafar *et al.*, 2005; Nolan *et al.*, 2001; Pakenham-Walsh, 2012; Wadhwani, Pitman, and Mody, 2005; Wardlaw, Salama, Johansson, and Mason, 2006). However, despite advances in technology, many health professionals and decision-makers—particularly those in low- and middle-income countries—lack the crucial information they need to make evidence-based decisions (Pakenham-Walsh and Bukachi, 2009; Pakenham-Walsh, 2012). When health care workers do not have access to and/or do not use the latest and most appropriate information, they cannot provide the highest quality care, and poor health outcomes—and even death—can result. Health information needs assessments show there is demand among health professionals for up-to-date, accurate, evidence-based, localized, and actionable information (Harlan, Sullivan, and Hailegiorgis, 2013; Kapadia-Kundu, Sullivan, Safi, Trivedi, and Velu, 2012; LeMay and Bocock, 2012; Sylla, Robinson, Raney, and Seck, 2012). KM can help meet this demand by uncovering knowledge, identifying specific knowledge needs, linking global health professionals to each other, and facilitating knowledge exchange and application at different levels of the health system.

When implemented strategically to complement other health interventions, KM interventions make global health programs more efficient and effective, streamline learning and knowledge exchange, facilitate innovative and creative solutions, and empower health practitioners with the capacity to act and to improve their performance (Kols and Kahan, 2004). In addition, there is some limited evidence of KM's contribution to health systems strengthening (Knowledge for Health, 2012), which is linked to improved health outcomes. However, as an emerging strategic area, KM for global health and development lacks the robust evidence of other health interventions—for example, vaccines to prevent infectious disease or antiretroviral therapy for treatment of HIV. Unlike these biomedical areas of global health, it can be difficult to attribute changes in health outcomes directly to social science interventions, such as KM, because many KM activities are implemented jointly with changes in service delivery, policy, or other improvements. Thus, there may be a confounding effect when attempting to show the impact of KM. Other KM activities may not show impact until months or years after they are initiated.

In order to successfully design, implement, and measure the effects of KM interventions, KM practitioners and researchers need a conceptual model that addresses a hypothesized causal

pathway to achieve intended results. To date, however, few tools and resources exist to systematically guide this process. Our paper attempts to fill this gap and offers a new model that is readily available as a programmatic tool for health professionals. In our analysis, we examine key concepts from traditional KM models, identify challenges to applying these concepts to global health, describe fresh approaches and key elements of the new logic model, and use a case study approach to systematically assess the new logic model to confirm its applicability to KM in global health and development. The paper further discusses the strength of the logic model and its unique contributions to the growing field of KM for global health and concludes with future directions and recommendations.

## 2. Literature Review: Traditional KM Models

Over the past few decades, several KM models have been put forth as guides to identifying, collecting, synthesizing, and sharing knowledge. The majority of these models are grounded in the business field, which has been at the forefront of promoting KM and its use in organizations (Nonaka, 1991; Rasula, Vuksic, and Stemberger, 2008). Adapting and applying these models to global health programs is challenging, particularly in terms of conceptualizing and measuring knowledge.

For example, the Data-Information-Knowledge-Wisdom (DIKW) Pyramid model defines learning as a hierarchical process, represented as a pyramid, with data forming the base, information and knowledge in the middle, and wisdom at the top (Bernstein, 2011; Fricke, 2007). Attributes of this model include extracting data and applying it in the form of information. Next, information is translated into instructions or explicit knowledge, which can then be used for decision-making. Criticisms of this model include its simplified approach to gathering information and the absence of other forms of knowledge, such as tacit knowledge (Bernstein, 2011). Furthermore, the DIKW model looks only at observable data and takes a broad approach to data collection, collecting all available data rather than using a focused methodology to answer a specific question (Fricke, 2007)

The Socialization-Externalization-Combination-Internalization (SECI) or Nonaka Spiral model addresses some of the shortcomings of the DIKW model by considering both tacit and explicit knowledge, and it views knowledge transfer as a continuous process running through the four areas in its name (Nonaka, 1991; Gourlay, 2003). Nonaka defines tacit knowledge as both intuition and subjective insights, which he posits can be converted into explicit knowledge through the use of linguistic tools, such as metaphors and analogies (Nonaka, 1991). While this model views the cycle of knowledge generation and application as never-ending, it is still linear in the sense that tacit knowledge is translated into explicit knowledge, rather than seeing the two as interconnected and occurring simultaneously. One criticism of this model is the lack of supporting data showing how the tacit-to-explicit knowledge conversion actually happens (Gourlay, 2003; Firestone and McElroy, 2003).

McElroy's Knowledge Life Cycle (KLC) approaches KM from a different perspective, examining existing knowledge and then identifying gaps in current knowledge, allowing for an iterative process in which organizational needs are cataloged and solutions to meeting knowledge gaps are tested (Firestone and McElory, 2003). The KLC model is different from other KM

models in that it details expected outcomes from knowledge production and integration, such as improved organizational knowledge and expansion of the organizational knowledge base. However, the KLC model is often criticized for its focus on KM activities without providing guidance on how to implement a KM system in an organization, which is also a common critique of other traditional KM models (Wong and Aspinwall, 2004).

In terms of measuring the impact of KM, the KM Maturity model measures KM within an organization to allow for comparisons with other organizations practicing KM (Rasula *et al.*, 2008). There are several variations of the KM Maturity model, with varying levels and definitions of KM competencies; examples of some of the dimensions used for comparing organizations include knowledge (accumulation, utilization, sharing, ownership), organization (KM strategy, learning, people, process), and information technology (capturing knowledge, usage of IT tools). Organizations are classified under five categories of maturity in terms of their mastery and implementation of KM activities (Khatibian, Hasan gholoi pour, and Jafari, 2010). While these maturity models can be helpful in grading an organization's progress, they have been criticized for being simplistic, lacking data to support categories of KM integration, and ignoring alternative paths organizations may take in their adoption of KM activities (Pöppelbuß and Röglinger, 2011).

The main challenge in applying these KM models to global health programs rests with linking KM processes to health-related outputs and outcomes. In addition, traditional KM models tend to focus heavily on technology-related solutions, providing little insight into KM approaches that can be implemented in resource-poor settings, where access to technology may be limited. The new Knowledge Management for Global Health (KM4GH) Logic Model, a practical tool for using KM techniques in global health projects, attempts to address these gaps, which we demonstrate through case studies of global and field-level initiatives.

## 3. Knowledge Management for Global Health Logic Model

Those who engage in global health and development activities play various roles in capturing, sharing, and applying technical knowledge to improve health programs, and they need practical guidance to help them operationalize KM concepts with the ultimate goal of enhancing program outcomes.

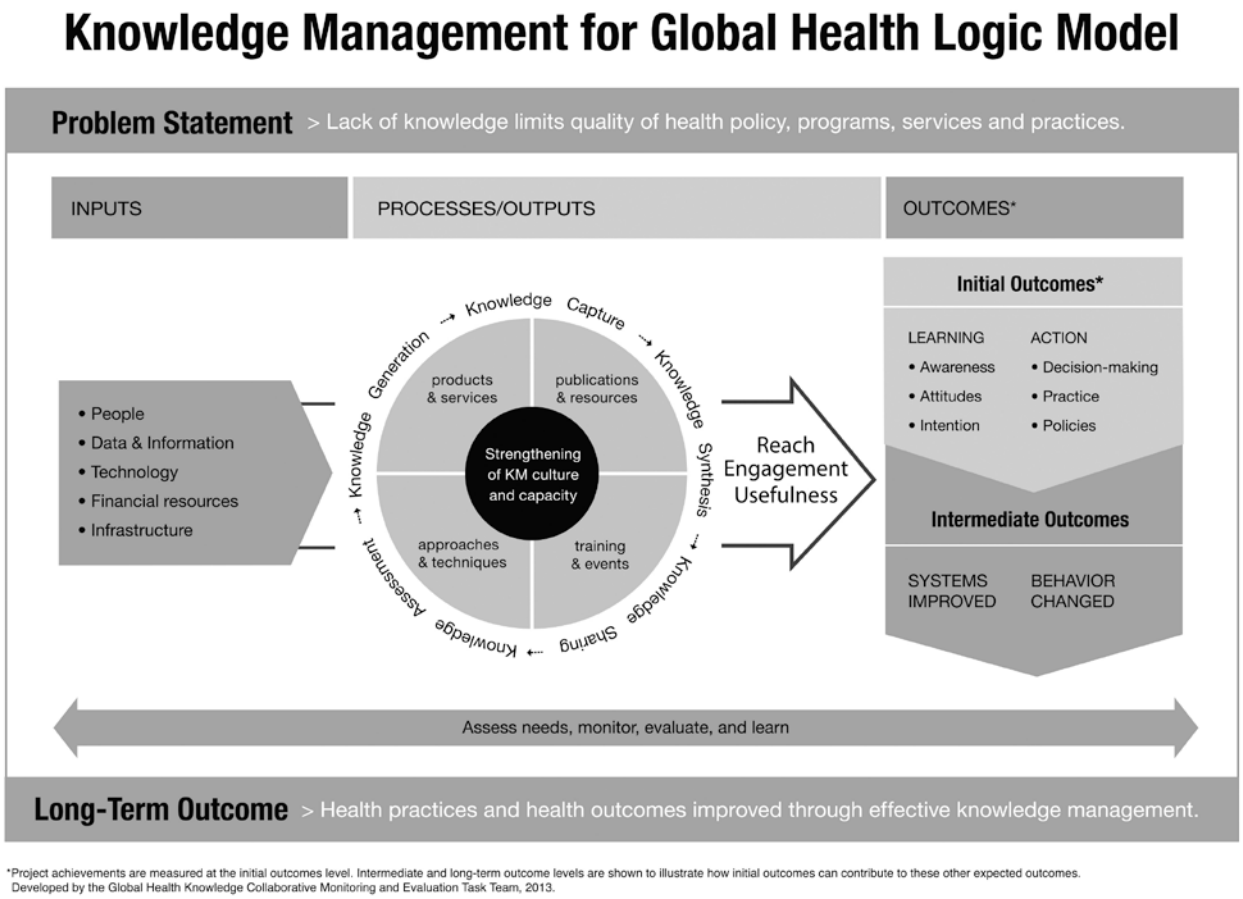
To meet the need and demand among global health professionals for practical and technical KM models, members of the Global Health Knowledge Collaborative (GHKC)[1] developed the KM4GH Logic Model (Figure 1) and the accompanying *Guide to Monitoring and Evaluating Knowledge Management in Global Health Programs* (Ohkubo, Sullivan, Harlan, Timmons, and Strachan, 2013).

The new KM4GH Logic Model is a hybrid of two existing models, which have gained some popularity in the health field: (1) a logic model for health information products and services developed in 2007 by the Health Information and Publications Network (HIPNet) (Sullivan, Timmons, and Strachan, 2007), and (2) the Knowledge Management Cycle (KMC) model

[1] A USAID-funded community of practice comprised of both KM practitioners and global health professionals from 45 countries. See https://www.globalhealthknowledge.org/.

(Evans, Dalkir and Bidian, 2014). GHKC first updated and expanded the HIPNet model. The KM4GH model adapts the main pathway/logic model structure of the HIPNet model, but it addresses a wide range of KM activities beyond health information products and services. GHKC also collected other models and theoretical frameworks from its member organizations and through a literature scan to examine common components that could be incorporated into the new model. This review revealed that many GHKC member organizations were using variations of the KMC model to guide KM activities. Therefore, the KM4GH model visually incorporated this unique and relevant circular representation of KM processes.

Figure 1. Knowledge Management for Global Health Logic Model




The KM4GH Logic Model fills the gaps and limitations of traditional KM models in a number of significant ways. First, the model specifies key elements that influence the uptake and application of knowledge, and it helps global health professionals plan ways in which resources and specific activities can work together to achieve desired outcomes. More specifically, the KM4GH Logic Model incorporates the following distinct approaches, which are essential to making the model useful and practical: (1) representation of a feedback loop and a continuous KM cycle, (2) classification of KM outputs and metrics to measure the outputs, (3) definition of stages of behavior change toward application of knowledge (i.e., from learning to action), and (4)

inclusion of elements to facilitate adaptation to programmatic contexts such as challenges and visions.[2]

### *3.1 Representation of the nature of KM – feedback loops and a continuous cycle*

Logic models are tools that visually display the sequence of actions and describe how these program components link to one another. Such models generally identify four key sets of components: inputs, processes, outputs, and outcomes. **Inputs** are the resources and assets invested into a program. **Processes** are the activities undertaken by the program. **Outputs** are the products and services created by the processes undertaken as well as the audiences who are targeted and reached as a result. **Outcomes** describe the anticipated changes and results, which can span different time periods including initial, intermediate, and long-term. Logic models, in general, depict linear pathways linking inputs, processes, and outputs to multiple levels of outcomes.

The new KM4GH Logic Model, however, diverges from the typical linear structure of logic models because the nature of KM work could be described as having feedback loops or continuous steps. In particular, processes are described in an unbounded cycle representing multiple stages of KM. While there are many variations, the KM cycle typically includes five processes: (**1) knowledge assessment, (2) knowledge capture, (3) knowledge generation, (4) knowledge synthesis, and (5) knowledge sharing.** These integrated processes continuously update and renew knowledge.

In addition, a double-sided arrow toward the bottom of the model, indicating "**Assess needs, monitor, evaluate, and learn,**" emphasizes the important feedback mechanism associated with KM. Throughout the KM process, and across the logic model, program implementers learn from needs assessment findings, program experience, research findings, and lessons learned and feed them back into inputs, processes, and outputs. The development and implementation of KM activities are meant to continuously improve in this manner. This feedback loop also ensures that KM activities are driven by and tailored to the needs of specific audiences.

### *3.2 Classification of unique KM outputs and metrics to measure them*

KM outputs are the products or activities that result from the processes in the knowledge cycle described earlier. Another unique aspect of this new logic model is its inclusion of specific examples of four categories of KM activities or outputs, covering a range of high- and low-end technology solutions: (**1) products and services** (such as websites, databases, and mobile applications)**, (2) publications and resources** (written documents)**, (3) training and events** (for example, workshops, webinars, and conferences)**,** and **(4) approaches and techniques** (such as after-action reviews, study tours, and face-to-face or online communities of practice).

These outputs are measured in terms of reach, engagement, and usefulness—basic but important KM metrics. **Reach** is defined as the breadth and saturation of dissemination, distribution, or referral of a KM output. **Engagement** is characterized by continuous action and commitment among users of a KM output to foster knowledge flow. **Usefulness** relates to how practical,

[2] The descriptions of the logic model in this section partly draw from Ohkubo *et al.*, 2013.

applicable, and beneficial a KM output is for users and can be determined by user perception and satisfaction as well as by other quality metrics.

Using these KM output types, KM practitioners or health professionals can easily modify the monitoring and evaluation (M&E) indicators to address specific contexts (Table 1).

Table 1. Four types of KM outputs, examples, and illustrative indicators

| KM output types | Examples of outputs | Illustrative indicators tailored to specific programmatic contexts |
|---|---|---|
| Products and services | Websites and Web portals, resource libraries, searchable databases, eLearning platforms, mobile applications, physical resource centers, and help desks | • Number of registered users of a help desk<br>• Number of links to Web products from other websites<br>• Number/percentage of users who are satisfied with the usability of mobile applications |
| Publications and resources | Written documents, such as policy briefs, guidelines, journal articles, manuals, job aids, and project reports | • Number of recipients who received a copy<br>• Number of times a publication is reprinted/reproduced/replicated by recipients<br>• Number/percentage of users receiving a publication that read it |
| Trainings and events | Workshops, seminars, meetings, forums, and conferences, including both in-person and online venues | • Number of participants in a workshop<br>• Number of sessions conducted by participants in a training of trainers<br>• Number/percentage of participants who are satisfied with the content presented in a seminar |
| Approaches and techniques | Practices for sharing knowledge, such as after-action reviews, peer assists, twinning, study tours, knowledge cafés, and communities of practice, to name some of the more popular KM approaches | • Number of people who made a comment or contribution<br>• Number of times a KM technique is replicated<br>• Number of people who liked the format of peer assists over a traditional presentation |

(Adapted from Ohkubo *et al.*, 2013)

### *3.3 Stages of behavior change grounded in theories*

Nurturing an organizational **culture that values KM** and **strengthening KM capacity** is crucial for motivating individual and organizational use of knowledge and for sustaining effective KM interventions. Such a culture can facilitate both organizational and individual performance improvements that ultimately contribute to the success of KM and global health programs.

As explained in the detailed guide accompanying the logic model (Ohkubo *et al.*, 2013), strategic guidance to strengthen KM culture and capacity can be enhanced by using an appropriate theory. There are a number of behavior change communication theories about why and how people change their behavior, which are also applicable to KM work and to this logic model. They can help guide KM programs to develop appropriate strategies that respond to an individual's or organization's context and information needs. For example, KM activities can be tailored or modified based on the Stages of Change theory, which helps identify where the user is in five cognitive stages on the path toward behavior change—pre-contemplation, contemplation, preparation, action, and maintenance (Prochaska and DiClemente, 1984). Diffusion of

Innovation is another useful theory, which proposes that people adapt a new idea through a five-stage process—knowledge, persuasion, decision, implementation, and confirmation (Rogers, 2003).

The five-stage "innovation-decision process" developed by Rogers has also informed the identification of two main categories of **initial outcomes** in the logic model—**learning** and **action**. Learning encompasses the progression from awareness of knowledge and one's attitude toward that knowledge to the intention to use that knowledge. The action stage occurs when a person puts new knowledge to use with a specific aim to change policies, programmatic guidance or procedures, or training or research methods (Sullivan *et al.*, 2007). In terms of measurement, fully capturing initial outcomes—both learning and action—can be challenging because those who are exposed to knowledge and have learned new skills may not have an opportunity to apply them immediately.

### *3.4 Adaptation to programmatic contexts*

The new KM4GH Logic Model is not meant to be a blueprint for any particular KM activity. Health and KM professionals should adapt it and develop their own models, considering their specific health situations and program priorities. To assist in this process, the logic model includes two elements that appear at the very top and bottom—the **problem statement** and the **long-term outcome**.

The problem statement identifies the issues or challenges that the KM program is designed to address. It helps all concerned parties—such as program implementers, stakeholders, and researchers—stay focused and motivated on the main scope of KM activities. The KM4GH Logic Model includes a general problem statement for a KM program in the field of health and development, which can be easily tailored to the different domains or focuses of a given program.

Similarly, the long-term outcome describes intended results and addresses the overall vision and strategic direction of a KM program. In the field of health and development, it generally relates to improving health status at the population level, such as reduction of mortality and morbidity. Although the KM4GH Logic Model includes a long-term outcome statement highlighting the pivotal role of KM to health improvements, we do not expect to be able to attribute health outcomes to the intended audience's exposure to specific KM interventions. Such KM interventions are one of many contributors to overall health programs, the impacts of which are, in turn, subject to numerous internal and environmental influences (Sullivan, Ohkubo, Rinehart and Storey, 2010).

## 4. Case Studies: Testing the KM4GH Logic Model

Once developed, it is important to test logic models to assess their validity. Using a case study format, this section illustrates how various elements of the KM4GH Logic Model have been used to design KM activities and to select M&E indicators. Specifically, this section maps three KM activities to the **processes** (KM cycle) and **outputs** (reach, engagement, and usefulness) elements of the KM4GH Logic Model and then demonstrates how KM activities can effectively contribute to the defined outcomes in the Logic Model, in particular to **initial outcomes** (learning and

action of the intended audiences) and even to **intermediate outcomes** (health systems improvement and client behavior change) in some instances. Furthermore, as emphasized in the KM4GH Logic Model, the case studies together highlight the importance of having a **problem statement** and a vision of the **long-term outcome** in order to select KM outputs that meet audience needs and to design appropriate KM strategies.

The main implementing group for the three KM activities described in this paper is the Knowledge Management Unit at the Johns Hopkins Center for Communication Programs (CCP). The mission of CCP's KM Unit is to promote the effective use of KM tools and practices to guide evidence-based global health programs and policies. In addition to working at the global level, the KM Unit has worked in several countries in Africa and Asia, with far-reaching partners, including non-profit organizations, universities, civil society groups, private companies, and government agencies.

The three case studies were derived from larger research studies or project evaluations examining the use of KM interventions to support health professionals working in global or country settings. Each of them employed a different set of data sources (Table 2). A review of both published and unpublished reports from the three cases was conducted to extract and consolidate essential results relevant to the use of the KM4GH Logic Model. This section describes the KM project or product background, research questions, objectives, and methods; examines how specific logic model elements were used and tested; and highlights the main findings.

Table 2. Geographic focus, KM activity type, and data sources of three case studies

| | Geographic focus | KM activity type | Data source |
|---|---|---|---|
| Case 1 | Malawi | SMS-based mobile phone network | Net-Map<br>Lot Quality Assurance Sampling (LQAS) survey<br>Focus group discussions (FGDs)<br>Key informant interviews (KIIs)<br>Mobile statistics from the SMS server |
| Case 2 | Global | Electronic Toolkits | Administrative records<br>Composite scores on website design and promotion<br>KIIs<br>Online survey<br>Web analytics |
| Case 3 | Bangladesh | Netbook-based eHealth | Pre-assessment survey<br>Post-assessment survey<br>KIIs<br>FGDs |

## *4.1 Case 1: Malawi K4Health Project*

### 4.1.1 *Project background*

The Malawi Knowledge for Health (K4Health) Project was implemented through a partnership between the Malawi Ministry of Health and the K4Health Project over an 18-month period (January 2010 to June 2011). This project was designed to address gaps in how information on

family planning and reproductive health (FP/RH) and HIV/AIDS is generated, shared, and used at all levels of the health system in Malawi (**problem statement**). Main KM activities consisted of: (1) forming a KM Task Force at the national level, (2) establishing two District Learning Centers, and (3) creating a mobile phone network using SMS (short message service, or text messaging) at the community level. These activities were envisioned to improve provider practices (**initial outcomes**) and capacity to provide quality health services (**intermediate outcomes**), which would contribute to the overall goal, or **long-term outcome**, of increasing contraceptive use and preventing HIV infection (although the long-term outcome was not explicitly articulated in the project design).

In this paper, we focus on the SMS-based mobile phone network activity. The objective of this activity was to improve communication and information sharing among community health workers (CHWs)—a cadre of frontline health care workers who provide basic treatment and preventative care usually in hard-to-reach communities. In Malawi, where there are far fewer physicians and nurses per capita than in neighboring countries (World Health Organization, 2013), CHWs have particular importance, as they are often the first—and frequently only—providers of health services in much of the predominantly rural country (Campbell *et al.*, 2014).

Between June and October 2010, the project provided training and mobile phones to 633 CHWs in the Salima and Nkhotakota districts. The innovative yet low-technology Frontline SMS software platform was used, enabling two-way SMS communications using only a laptop computer at the Hub and a mobile phone (without Internet access) provided to each CHW.

#### 4.1.2 *Study design and methods*

The SMS activity was evaluated using both qualitative and quantitative methods between May and June 2011. Evaluation questions that were relevant to the SMS component of the project included: (1) To what extent did the SMS network in Salima and Nkhotakota reduce the communication gap between health workers and their district teams and thereby increase access to technical information among these health workers? and (2) To what extent did the SMS network in Salima and Nkhotakota improve the ability of health workers to provide quality services and care?

Information was collected from a variety of sources, including Net-Maps,[3] which examined FP/RH and HIV/AIDS information flows at national and district levels; a survey of CHWs using Lot Quality Assurance Sampling (LQAS)[4]; focus group discussions (FGDs) and key informant interviews (KIIs); and mobile statistics from the SMS server (Hub) for SMS users.

[3] An interview-based tool that helps people "understand, visualize, discuss, and improve situations in which many actors influence outcomes" (Schiffer and Hauck, 2010). It was used at two points (baseline in 2010 and end line in 2011) to compare information flows with district-level stakeholders before and after the intervention (Campbell *et al.*, 2014).

[4] A random sampling methodology used to obtain evaluation survey data from CHWs (Campbell *et al.*, 2014).

### 4.1.3 *Results*

Because the SMS activity was implemented at the community level with direct access to the audience of CHWs and their supervisors, the project was able to evaluate the activity at all levels of the KM4GH Logic Model (Table 3).

Table 3. KM4GH Logic Model elements and variables in Case 1 (Malawi)

| Logic model elements | Specific variables |
|---|---|
| Processes:<br>KM Capacity and Culture | • Mobile phone training received<br>• Degree of trust among CHWs |
| Outputs:<br>Reach and Engagement | • Number of text messages sent by CHWs<br>• Degree of communication and information sharing among CHWs |
| Outputs:<br>Usefulness | • Usability (of mobile phones) |
| Initial Outcomes:<br>Learning | • CHWs' self-confidence<br>• CHWs' knowledge |
| Initial Outcomes:<br>Action<br>(Decision-making and Practice) | • Time for CHWs to report events<br>• Time before receiving feedback from supervisors |
| Intermediate Outcomes:<br>Improved systems | • Timeliness (speed of delivery of high-quality information among health workers)<br>• Cost of communication<br>• Service coverage<br>• Efficiency of referrals |
| Intermediate Outcomes:<br>Attitude (of Communities) Changed<br>(Prerequisite to Behavior Change) | • Trust between CHWs and the communities |

At the outcomes level, the evaluation found that this intervention improved not only reach and engagement but also the initial outcomes of decision-making and practice (service delivery) as well as intermediate outcomes related to systems. For example, in terms of **reach and engagement**, the average number of SMS messages sent by CHWs increased from 44 messages per month between June and October 2010 to 1,091 messages per month between mid-November 2010 and mid-June 2011.

More importantly, CHWs considered mobile phones an easy tool to use (**usefulness**), and the SMS activity improved **decision-making and practice** by greatly reducing the communication gap between health workers and their district teams. For instance, CHWs in intervention districts took notably less time than their counterparts in control districts to report important events, such as commodity stockouts and transportation breakdowns. At endline, the average time required for CHWs to report such events was 3 minutes, compared with 523 minutes for the control district of Nkhatabay during the same time period.

Finally, the SMS activity improved health services, for example, by substantially decreasing the time for CHWs to receive technical support from their supervisors. CHWs participating in the SMS network reported it took 9 minutes to receive technical support at endline, compared with 1,681 minutes (1.2 days) for CHWs in the control district of Kasungu at mid-term and 1,498

minutes (1 day) for CHWs in another control district (Nkhatabay) at endline. Furthermore, CHWs reported more prompt responses to obstetric emergencies, and even to an emergency response to a measles outbreak.

Overall, this project contributed to health systems strengthening. Recognizing and preventing stockouts was an important result of this intervention, as reported by the CHWs. Further, the SMS network increased CHW self-confidence, increased trust between CHWs and the communities they serve (**clients' attitude changed**—a prerequisite of behavior change), decreased the cost of communication, widened service coverage, and increased the efficiency of referrals (**systems improved**).

### *4.2 Case 2: K4Health Toolkits*

#### 4.2.1 *Product background*

Health care professionals around the world lack access to high-quality KM tools and resources (**problem statement**). K4Health's electronic Toolkits platform addresses this problem by providing quick and easy access to relevant and reliable health information in one convenient location, intended for health program managers, service providers, and policy makers. K4Health strives to keep the Toolkits up-to-date so that health professionals can access the information they need to develop policies, design programs, and make health care decisions based on evidence, with the overall vision of improving their performance and health practices in the communities they serve (**long-term outcome**).

The resources in Toolkits are selected by subject matter experts from a wide range of organizations, including donor agencies, nongovernmental organizations, professional networks, and communities of practice**.** Some Toolkits are developed with a high level of collaboration among different organizations; others are developed more independently.

Launched in October 2009, the platform currently offers approximately 75 Toolkits on a wide range of health topics including contraceptive methods, FP/RH programs and services, HIV/AIDS, maternal and child health, environmental health, gender, and cross-cutting technical areas such as mobile health (mHealth), KM, and leadership and management. The Toolkits are available online (https://www.k4health.org/toolkits/) as well as in offline formats such as CD-ROMs and flash drives. Some Toolkits cover broad topics, such as monitoring and evaluation of health programs; others have a more narrow scope, such as specific contraceptive methods (e.g., injectables or implants). All Toolkits use a similar interface, but some Toolkit builders design Toolkits as a collection of resources with little curation ("unfocused" Toolkits) whereas other builders are more selective in the resources they include and provide more information synthesis ("focused" Toolkits).

#### 4.2.2 *Study design and methods*

In 2013, for the purpose of distilling common elements of effective Toolkits, K4Health selected 21 Toolkits using a set of criteria (to ensure we had a broad representation of Toolkit types) and conducted a mix-methods study. Specific research questions were: (1) What are good approaches

for developing, monitoring, and maintaining a high-quality Toolkit? (2) What are important content elements of a Toolkit that make it useful to and used by users? and (3) What are key factors to improving the user experience?

The study included the following data sources and data collection methods: (1) administrative records from the Toolkit Monitoring System, (2) composite scores measuring adherence to website design best practices and initial and ongoing promotional efforts, (3) interviews with Toolkit builders, (4) survey of Toolkit end-users, and (5) Web analytics. Data for this study were collected, organized, and analyzed using MS Excel.

The study focused on four independent variables: collaboration (in building the Toolkit), maintenance, promotion, and website design. Categorical values of these four independent variables were transformed to numeric data (e.g., low=1, medium=2, high=3). To conduct the analysis, we first analyzed the selected Toolkits vis-à-vis these four variables. We used simple correlation analysis to explore relationships between variables and to test our assumptions, such as whether there was a positive correlation between collaboration in building a Toolkit and adherence to website design best practices. Seeking additional insight, we also examined each variable by stratifying the data according to Toolkit characteristics (e.g., broad vs. narrow topic, focused vs. unfocused Toolkit design). Correlation scores were organized into tables to identify three possible types of relationship (positive, negative, none) and the strength of the association (ranging from -1.00 to +1.00).

### 4.2.3 *Results*

The Toolkit study revealed several positive correlations between the variables mapped to **processes** (i.e., collaboration, maintenance, promotion, and design structure) and the variables mapped to **reach, engagement, and usefulness** (mostly by analyzing Web analytics, including Web traffic "quantity" indicators, such as number of resource downloads and number of referring sites, and Web usage "quality" indicators, such as average time on site, pages viewed per visit, and ratio of new to returning visitors) (Table 4). We also examined associations among the four process variables. A low response rate among surveys of end-users prohibited us from assessing the effect of Toolkits on initial outcomes of learning and action.

Table 4. KM4GH Logic Model elements and variables in Case 2 (Toolkits)

| Logic model elements | Specific variables |
|---|---|
| Processes:<br>Knowledge assessment, generation, capture, synthesis, and sharing | • Collaboration<br>• Maintenance<br>• Promotion<br>• Website design |
| Outputs:<br>Reach and Engagement | • Web traffic (quantity) |
| Outputs:<br>Usefulness | • Web usage (quality) |

Using correlation values, data analysis regarding the Toolkit-building process revealed that increased collaboration when building a Toolkit generally fostered both continued maintenance of the Toolkit over time (r=0.73) and more promotion of the Toolkit (r=0.82). These trends were notable in particular for Toolkits that covered a broader range of topics. Regular Toolkit maintenance also was strongly related to higher adherence to website design best practices (r=0.63) and promotion (r=0.63).

In terms of the effect of Toolkits on **outputs** defined in the logic model, "focused" Toolkits had greater **reach and engagement** (measured by overall Web traffic) and **usefulness** (measured by Web usage quality) (r=0.96). These focused Toolkits also clearly showed that regular maintenance was associated with higher composite scores of good website designs (r=0.73), which are likely to be easier to use and therefore to be more **useful** among end-users. Promotion was strongly linked to increased Web traffic (r=0.63); however, it alone did not have a significant effect on Web usage quality (r=0.34).

Overall, the study confirmed several assumptions of the Toolkits study team. In terms of processes, greater collaboration when developing a Toolkit may require more time and resources, but it facilitates better promotion and maintenance. This is likely because the participatory approach promotes ownership among a wider range of partners, which allows distribution of the work required to build and maintain a high-quality Toolkit. Furthermore, increased promotion leads to greater reach but not necessarily to more engagement among users or to usefulness of the Toolkit. To ensure engagement and usefulness, the Toolkits themselves must be designed with the perspective of the end-user in mind; namely, they should adhere to best practices in website usability design by synthesizing information and curating a more selective package of resources rather than providing an extensive library of resources that the users then have to sort through themselves.

### *4.3 Case 3: Bangladesh Knowledge Management Initiative*

#### 4.3.1 *Project background*

In Bangladesh, CHWs provide vital health information in rural parts of the country, where access to health services is limited and resources are scarce. CHWs visit homes and counsel families on various health issues, such as: nutrition; maternal, neonatal, and child health (MNCH); and FP/RH. However, CHWs counsel clients only on certain topics within these fields and do not provide integrated health messaging; in addition, health counseling materials provided to CHWs are not always up-to-date (**problem statement**). The Bangladesh Knowledge Management Initiative (BKMI) aimed to improve the health and nutrition status of mothers and children by strengthening sustainable KM and communication initiatives through innovations, partnerships, capacity building, and appropriate technology (**long-term outcome**).

In collaboration with the Bangladesh Ministry of Health (BMOH), BKMI conducted an eHealth pilot project in the Sylhet and Chittagong districts over a four-month period, from May to August 2013. The project developed a Health, Population, and Nutrition (HPN) Toolkit and eight online courses to provide current and integrated health information on nutrition, MNCH, and FP/RH to CHWs and their clients. To ensure that these eHealth resources could be used with both CHWs

and their clients, information was presented in audio and visual formats, conducive to low-literate populations. Since CHWs needed a portable resource that they could easily carry with them during their shifts, but Internet connectivity was limited or absent in parts of the country, the resources were downloaded onto netbooks. The netbooks were distributed to 304 CHWs (one netbook per CHW) in 12 *upazilas* (sub-districts) in the two pilot districts.

#### 4.3.2 *Study design and methods*

CHWs (n=304) and their clients (n=675) were given pre- and post-assessment surveys (before and after the pilot), to test their knowledge of FP/RH, nutrition, and MNCH topics. CHW assessment surveys included sections on communication and technology skills, in addition to the health topics, and were also asked about their use of eHealth resources during counseling sessions. Interviews and focus group discussions were also conducted with CHWs and clients, but this case study focuses primarily on results from the pre- and post-assessment surveys.

#### 4.3.3 *Results*

The BKMI project served all CHWs in the two pilot districts, **reaching** 304 CHWs with netbooks and eHealth resources. The project activities covered all levels of the KM4GH Logic Model (Table 5). The assessment surveys demonstrated that the project improved **learning** among the CHWs. For example, the pre-test and post-test results showed an overall trend of increased knowledge in family planning, maternal danger signs, prevention of diarrhea, complementary food, and skilled birth (Mitchell, 2014; K4Health, 2014). In addition, self-reported data from CHWs indicated they had used the eHealth resources during counseling with their clients and they had increased integrated messaging (**action: practice**) (K4Health, 2014).

Clients were also asked about their knowledge of health topics and their perception of CHWs before and after the intervention, which are prerequisites for changing clients' behaviors (**intermediate outcome**). The clients demonstrated improved health knowledge, such as knowing typical side effects of contraceptives (30% at pre-test to 42% at post-test) and danger signs during pregnancy and childbirth, such as high fever (38% to 49%) and convulsions (60% to 76%). Use of the netbooks also increased credibility of CHWs among their clients; the clients found the CHWs to be more knowledgeable and well-informed about nutrition (29% to 49%), family planning (37% to 54%), and MNCH (18% to 48%).

The missing component of the pre- and post-assessment was the inclusion of measurements directly related to **behavior change** among clients, such as use of contraceptives and changes in maternal and newborn feeding practices. Such behavior change would require a longer intervention period, as sustained health messaging would be required for any discernible differences to emerge in health behaviors.

Data from FGDs and KIIs indicated that once CHWs realized the **usefulness** of the eHealth resources and the ease in which they could operate the netbooks, these devices became an integral part of their approach to counseling clients. The success of the eHealth pilot has led to efforts to scale-up dissemination and use of the Toolkit and online courses. The BMOH, along

with other implementing partners, is promoting use of eHealth resources among CHWs and health facilities in other areas of the country.

Table 5. KM4GH Logic Model elements and variables in Case 3 (Bangladesh)

| Logic model elements | Specific variables |
|---|---|
| Processes:<br>KM Capacity and Culture | • Training of CHWs on netbooks and eHealth resources |
| Outputs:<br>Reach and Engagement | • Number of CHWs served by the eHealth pilot |
| Outputs:<br>Usefulness | • Usability of netbooks |
| Initial Outcomes:<br>Learning | • Knowledge among CHWs |
| Initial Outcomes:<br>Action<br>(Decision-making and Practice) | • CHWs' use of netbooks to improve counseling<br>• CHWs' use of eHealth knowledge to provide integrated health counseling |
| Intermediate Outcomes:<br>Attitude and Knowledge (of Clients) Changed<br>(Prerequisite to Behavior Change) | • Knowledge among clients<br>• Clients' perceptions of CHWs and eHealth resources |

## 5. Discussion

These three case studies collectively help us gain understanding on KM processes and outputs necessary to achieve desired outcomes, and together they validate various elements of the KM4GH Logic Model (Table 6).

Table 6. Primary indicators from the case studies mapped to KM4GH Logic Model elements

| | Type of Indicators (logic model elements) | | | | |
|---|---|---|---|---|---|
| | Processes | Outputs: Reach and Engagement | Outputs: Usefulness | Initial Outcomes: Learning and Action | Intermediate Outcomes (e.g., health systems improved, clients attitudes changed) |
| Case 1: Malawi | X | X | X | X | X |
| Case 2: Toolkits | X | X | X | | |
| Case 3: Bangladesh | X | X | X | X | X |

The study results from case 2 (Toolkits) confirm that multiple stages of the KM cycle work together continuously to enhance overall KM processes, and improved processes then influence outputs. In the absence of a more focused KM project or field presence, it is challenging to measure initial and intermediate outcomes of Toolkits. With more rigorous evaluation designs, both case 1 (SMS component of the Malawi K4Health Project) and case 3 (Bangladesh BKMI eHealth pilot) are able to illustrate that effective KM interventions that meet the information needs of health workers and that improve their capacities can contribute to a higher level of outcomes.

These case studies also demonstrate clearly the flexibility of the KM4GH Logic Model in defining a menu of KM activities and outputs, from Web-based products and publications to low-tech mobile applications, with a common set of metrics to measure their effect on audiences

(starting with reach, engagement, and usefulness and continuing through three levels of health outcomes). These metrics provide global health organizations the ability to compare and contrast the utility of different KM activities and to select the most appropriate activity to meet the specific information and knowledge needs of an audience. For example, a Web-based product, such as an electronic Toolkit, may be an appropriate product to disseminate a package of resources with the intention of increasing knowledge of global standards and practices to a wide range of audiences around the world. However, as the Malawi K4Health Project demonstrated, a low-tech mobile application that connects health workers with each other and with their supervisors would be more appropriate to provide real-time answers to health workers' questions and to enhance supervision. Furthermore, eHealth approaches may be considered as an intervention to effectively improve knowledge and counseling skills among health workers, as confirmed by the BKMI project. Such field-level interventions also make it easier to measure impact on service quality and overall health systems.

Perhaps the most unique contribution of the KM4GH Logic Model to the global health field is that it not only defines the steps of a continuous KM cycle but also incorporates outcomes into the model (with a comprehensive list of sample indicators included in the accompanying *Guide to Monitoring and Evaluating Knowledge Management in Global Health Programs*). This helps global health organizations and professionals plan KM activities with the end in mind rather than doing KM for the sake of KM. Furthermore, three levels of outcomes—initial, intermediate, and long-term—are clearly depicted in the model, which are grounded in behavior change theory. The initial outcomes in the model draw from the stages of the "innovation-decision" process, which are grouped into the two categories of "learning" (broken down further into awareness, attitudes, and intention) and "action" (which is applied in the three areas of decision-making, practice, and policies). These categories help to show the progression in the behavior change process, from awareness of an innovation (or new knowledge) to one's attitudes toward the innovation to the intention to use the innovation. Most KM activities can demonstrate their contribution to this initial level of outcomes through surveys, interviews, and knowledge assessment tests, as was achieved in the Malawi K4Health Project and BKMI eHealth pilot described earlier.

But the model does not stop there. One of the key objectives of KM programs in global health is for health professionals to put knowledge to use to improve programs and practices. The "action" categories of outcomes constitute the adoption of knowledge for decision-making purposes or for application in practice and policy. Intermediate and long-term outcomes are also included in the model to show that KM can contribute to changes in systems and in client behaviors, and ultimately to improvements in the health condition or status of communities and individuals. The model does not expect, however, that KM activities would be evaluated on the basis of long-term health indicators (thus, the depiction of the long-term outcome at the bottom of the model, one step removed from the "outcomes" column), since knowledge is often necessary but not sufficient for changes in health status.

All these aspects of the KM4GH Logic Model make it a ready-to-use, practical tool for global health professionals to better design, implement, and measure the impact of their KM efforts. While comprehensive in presenting key logic model elements, including inputs, processes, outputs, and outcomes, the logic model is not meant to be a blueprint for any particular KM

activity in a specific global health topic area. Rather, the model can and should be tailored and adapted for any KM activity in any global health topic area, after first considering the specific health situation and priorities of the setting in question. For example, a maternal and child health program might adapt the KM4GH Logic Model to focus specifically on persuading policy makers to increase the scope of practice for midwives in a particular country. On the other hand, an HIV prevention program might focus on improving health care providers' knowledge about proper infection prevention measures and enabling them to adopt appropriate practices. A family planning mHealth project, such as the Malawi K4Health Project described earlier, could aim to improve service delivery provided by CHWs by offering accurate and up-to-date health information at the point-of-care while tracking and ensuring consistent commodity supplies.

## 6. Recommendations for Future Research

While the KM4GH Logic Model fills many gaps found in other traditional KM models, it is not intended to be static. KM continues to mature in the global health and development field, providing opportunities to continually enhance the current discourse. There are a number of emerging issues we think would further benefit KM research, including measuring intention to use knowledge (versus actual use of knowledge), developing appropriate evaluation designs for KM interventions, and realigning KM to center on people rather than technology.

### *6.1 Measurement of intention to use knowledge versus actual action*

Current debates on evaluating the success of KM center around measuring actual use of knowledge, as opposed to the intention to use knowledge. KM studies on this issue have been mixed, with some arguing that actual use is a good indicator and others stating intention to use is a better measurement (Jennex, 2008; Rai, Lang, and Welker, 2002). The drawback of assessing only intention to use is that users may not apply their knowledge despite reporting that they will. In this paper, we suggest that both approaches are acceptable, depending on the context in which a KM system is implemented. For example, in Bangladesh, our direct contact with CHWs allowed us to accurately measure their learning and application of eHealth resources. In Malawi, we were able to monitor SMS use and, through qualitative methods, determine benefits of the mobile network—CHWs were able to quickly communicate with colleagues, answer client questions, and report medical commodity stockouts. These case studies illustrate that it is much easier to measure actual use at the field level, compared with the larger systems level. In these situations, measuring intention to use may be an acceptable alternative to gauging the success of a KM system. With any KM system, the evaluation plan must be designed with the end-user in mind as well as with consideration to the feasibility of collecting certain types of data within the constraints of the context in which KM is implemented.

### *6.2 Use of appropriate research and evaluation designs*

Another emerging issue debated in the KM for global health field is identification of innovative research designs to assess the impact of KM. Most existing evaluations of KM activities in this field have emphasized process evaluation (monitoring) and have collected and analyzed simple routine data or self-reported information to assess the reach and usefulness of KM activities (Sullivan *et al.*, 2010). In recent years, to design effective KM interventions to support a global

health agenda, the need to systematically understand intended audiences and their surrounding contexts have been recognized, and more resources have been invested to support formative research (D'Adamo, Fabic, and Ohkubo, 2012). Additionally, in order to continue to make a strong case for KM and to communicate its value with various global health organizations and professionals, more attempts have been made to collect concrete evidence of the impact of KM from special studies and outcome evaluations as illustrated in our three case studies.

While much progress has been made, KM scholars need to continue to apply stronger research and evaluation approaches to isolate a causal pathway leading from specific KM activity areas to intended health outcomes. Evaluating the effectiveness of KM interventions requires rigorous research designs to measure outcomes such as learning, knowledge gain, performance improvement, and behavior change. Obtaining random samples may not be possible in certain situations, but this limitation can be addressed through other research methods, such as control groups to compare intervention and non-intervention sites or pre-post assessments.

### *6.3 Shift in emphasis on social KM*

The KM field generally recognizes three main components of successful KM approaches: people, processes, and technology. The field has a tendency, however, to focus on technology-related solutions to improve organizational performance. Because technology is limited in many of the resource-poor settings in which global health organizations operate, KM scholars in the global health field have begun to call for a shift in emphasis, from a focus on technology to one on people and their knowledge needs—what they are referring to as "social KM" (Hendrix-Jenkins, 2014; Harlan *et al.*, 2013). Future KM projects and experiments should explore the role of (in-person and virtual) social networks in the diffusion and use of knowledge, with greater emphasis on how social KM approaches can improve health programs and practices.

## 7. Conclusions

The KM4GH Logic Model can be a useful tool for guiding health professionals in designing and evaluating appropriate KM activities to achieve intended program results. By incorporating three levels of outcomes into the model, this new logic model makes a unique contribution to the relatively nascent field of KM for global health by illustrating the importance of planning KM activities with the end goal in mind. While not intended to be a blueprint for any particular KM activity, health professionals can adapt the model, considering the specific health situations and priorities of the programs with which they work.

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